IVM PEA Supplemental Environmental Assessment:

Indoor Residual Spraying
Using Registered Carbamates,
Pyrethroids and DDT in Mozambique

January 30, 2008

This publication was produced for review by the United States Agency for International Development. It was prepared by RTI International.

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ENVIRONMENTAL ASSESSMENT FOR
IRS USING CARBAMATES, PYRETHROIDS AND DDT FOR MALARIA CONTROL IN MOZAMBIQUE

PROGRAM/ACTIVITY DATA:

Program/Activity Number:	656-0008
Country/Region:	Mozambique/AFR
Program/Activity Title:	SO8: Integrated Health Sector (HIS) Strategic Objective Agreement (SOAG)
Sub-Activity:	IRS Using Carbamates, Pyrethroids and DDT for Malaria Control in Mozambique

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ENVIRONMENTAL ACTION RECOMMENDED: (Place X where applicable)

Categorical Exclusion: ____ Negative Determination: ____
Positive Determination: _X__ Deferral: ____

ADDITIONAL ELEMENTS: (Place X where applicable)

CONDITIONS: ____ PVO/NGO: ____

SUMMARY OF FINDINGS:

This program is associated with the U.S. President's Malaria Initiative (PMI) in Africa, which seeks to reduce malaria mortality by 50% in up to 15 countries in sub-Saharan Africa by 2010. The United States will work in partnership with host governments and build on existing national malaria control plans, policies, and resources. The PMI will support and complement the efforts of the Global Fund, the World Bank, and other members of the Roll Back Malaria Partnership. Mozambique is one of four second-year countries to be selected for PMI.

The Initial Environmental Examination in 2005 of the United States Agency for International Development (USAID)/Mozambique's Strategic Objective (SO) 8, Integrated Health Sector (HIS) Strategic Objective Agreement (SOAG) identified distribution, re-treatment, and use of re-treatable Insecticide Treated Nets (ITNs) and

Long-Lasting Insecticidal Nets (LLINs) as a major intervention for malaria control, for which a Negative Determination with conditions was recommended. The conditions to be met were listed in the Safer Use Action Plan (SUAP), and based on recommendations from the *Programmatic Environmental Assessment for Insecticide-Treated Materials in USAID Activities in Sub-Saharan Africa* (ITM PEA).

As part of a new malaria control program under the PMI, USAID proposes to implement an Indoor Residual Spraying (IRS) program in Mozambique using carbamates, pyrethroids, and dichloro-diphenyl-trichloroethane (DDT) for malaria vector control. Mozambique is characterized by perennial malaria transmission, and IRS would be used to reduce malaria incidence in the seasons of highest transmission. Another aspect of malaria vector control supported by the Ministry of Health (Ministerio de Saude, henceforth referred to as MISAU) includes ITNs and LLINs. In the long-term, larviciding and environmental management are being pursued to provide an integrated malaria vector control strategy, although these interventions are largely on an operational research basis, are not presently part of the main vector control strategy, and are not covered by this Supplemental Environmental Assessment (SEA).

A **Positive Determination** is recommended for this program, per 22CFR216.3(a)(ii)(3), because of the potential for the pesticides proposed for use to have a significant impact on the environment, and per 22CFR216.3(b)(iii)(b), because the U.S. registration of one of the chemicals proposed for use – DDT– was cancelled by USEPA, and registration of bendiocarb in the US was voluntarily cancelled by manufacturers.

This Supplemental Environmental Assessment tiers off from USAID's *Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (IVM PEA). It identifies the mitigating measures by which the potential for impact on the environment and human welfare and well-being can be minimized and the benefits of the program maximized. The conditions are that the MISAU and MICOA, with as much assistance from the Ministry of Agriculture (MINAG) and USAID as necessary, will implement the risk reduction actions outlined in the Supplemental Environmental Assessment (SEA) and summarized here and in the section entitled REQUIRED AND RECOMMENDED MITIGATION MEASURES: The Safer Use Action Plan. An overview of conditions of the Supplemental Environmental Assessment (SEA) is detailed below.

1. *The following pesticides are registered in Mozambique, are available for use in IRS, and covered by this SEA*:

    - Alpha-cypermethrin WP
    - Bendiocarb WP
    - DDT WP
    - Deltamethrin WP and WG

- Etofenprox WP
- Lambda-cyhalothrin WP and CS

Additional pyrethroids and carbamates may become registered in coming years, and USAID may support their use under this SEA. This SEA does not address the use of organophosphates—note that pirimiphos-methyl EC is also registered in Mozambique, but is not covered by this SEA. USAID reserves the right to revoke support for a particular insecticide product based on technical grounds described in *Pesticide Procedures B, Basis for Selection of the Requested Pesticide*, particularly when vector susceptibility and efficacy are in question.

2. *In support of subsequent IRS campaigns supported by USAID, this Supplemental Environmental Assessment will be reviewed and revised every year* as needed to ensure the USAID support remains consistent with stipulations in Annex B, Part II of the Stockholm Convention (http://www.pops.int), Mozambique's National Implementation Plan (NIP), and Stockholm Convention party reporting requirements for DDT use, which can be found at http://www.pops.int/ddt_info/default.htm.
3. *To re-examine the need for DDT and to identify the best choice for IRS chemicals* (considering safety, effectiveness and affordability in accordance with Annex B, Part II of the Stockholm Convention), USAID will work with MISAU and MICOA every year as needed. At that time, this SEA must be amended to reflect the continuing need, if appropriate, for DDT.
4. *USAID will assist MICOA and MISAU in completing activities necessary to fulfill Stockholm Convention reporting requirements.*
5. *USAID will assist MISAU in completing a domestic EIA required by Mozambique's EIA Guidelines.*
6. *The Safer Use Action Plan is to be implemented* with relevant partners as a management tool for dealing with and accomplishing the program objectives in a safe manner.
7. *IRS supervisors, team leaders, and spray operators will be trained* by the USAID contractor according to WHO standards as well as MINAG standards. Insecticide poisoning management training will be provided to health workers. Pyrethroid, DDT and carbamate poisoning treatment medications will be provided to trained health workers by MISAU and the USAID contractor. In the specific districts where USAID is providing support, insecticide storage facility storekeepers will also be trained by MINAG and FAO (in collaboration with the USAID contractor) on proper stores management.
8. *Occupational exposure to insecticides will be minimized through personal protective equipment* (according to WHO specs). An IEC campaign will educate house owners on their roles and responsibilities during the spray campaign to avoid exposure, and supervisors will remind residents of these responsibilities during spray campaign. The IEC Campaign will also educate the population to avoid using pesticides that are not

registered or certified for Agricultural commodities by the Ministry of Agriculture and the Ministry of Health.

9. Women shall not be employed as spray operators themselves, but may work in ancillary roles as community mobilizers, enumerators or supervisors.
10. *Environmental contamination will be kept to a minimum through strict auditing, handling, and washing practices.* Each insecticide sachet will be strictly accounted for and contaminated waste-water/rinse-water will be re-used in subsequent days of spraying through the "progressive rinse" system which is part of the standard training packet.
11. Results of the public comment meeting indicate that the following issues are critical to the program:
    - Involvement of all stakeholders, particularly the community;
    - Minimization of potential collateral effects (thefts and misuse);
    - Training of both sprayers and supervisors;
    - Monitoring the efficacy of the spraying program.

    The public comment meeting also highlighted issues that, while addressed in this SEA, should be major focal points of the IRS program:
    - Community education is essential for the program;
    - Clear and precise information on procedures to the community in order to permit them to follow up the sprayers' actions;
    - Strong social mobilization;
    - Selection and recruitment of sprayers, in a very strict way, focusing on the maturity and integrity;
    - Strict training of sprayers, supervisors, storehouse workers and drivers;
    - Creation and enforcement of mechanisms of control of used insecticides in order to minimize theft and inappropriate applications.
12. *In the districts where USAID is providing support, secure storage with adequate capacity for IRS insecticides and associated materials must be provided by MISAU in collaboration with MINAG and the USAID contractor.* Current infrastructure is inadequate to house enough insecticide for the intended scale-up of IRS operations in Mozambique. Adequate storage, constructed or renovated according to FAO and MINAG standards, is required for support of Mozambique's IRS program.
13. *Hazardous waste transport and disposal resulting from IRS operations will comply with national and international guidelines.* Empty DDT sachets will be collected by the program and exported for safe disposal. Safe disposal requires an FAO-approved incinerator; however, an FAO-approved incinerator does not exist on the African continent. Thus safe disposal will require export of IRS waste materials to Europe, or storage of IRS waste materials in storage facilities until an African incinerator can be constructed or refurbished according to FAO standards. Additionally, bilateral

14. *As required by Automated Directives System (ADS) 204.5.4, the Strategic Objective (SO) team will actively monitor ongoing activities for compliance with the requirements and recommendations in this assessment*, and modify or end activities that are not in compliance. USAID Mozambique has developed an Environmental Monitoring and Mitigation Tracking System (EMMTS), which USAID team members shall use to monitor during IRS campaigns. If additional activities are added to this program that are not described in this document, an amended SEA must be prepared and approved prior to implementation of those activities. This includes any commodities, including pesticide products, being considered under the program but not covered in the present SEA.

APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED:

CLEARANCE:
Environmental Officer, Bureau of Global Health: _____ Date: _____
Michael Zeilinger

CONCURRENCE:
Mission Director, USAID Mozambique: _____ Date: _____
Todd Amani

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Acronyms

ACTs	artemisinin-based combination therapies
ATSDR	Agency for Toxic Substances and Disease Registry
C	Celsius
CDC	US Centers for Disease Control and Prevention
DDT	Dichloro-diphenyl-trichloroethane
FAO	Food and Agriculture Organization
GFATM	The Global Fund to Fight AIDS, Tuberculosis, and Malaria (referenced as "Global Fund")
IEC	Information, Education and Communication
IEE	Initial Environmental Examination
INS	Mozambique National Institutes of Health
IPCS	International Programme on Chemical Safety
IPT	intermittent preventive treatment
IRS	Indoor Residual Spraying
ITM PEA	Programmatic Environmental Assessment for Insecticide-Treated Materials in USAID Activities in Sub-Saharan Africa
IVM PEA	Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment
ITNs	Insecticide Treated Nets
IVM	Integrated Vector Management
KAP	Knowledge, Attitudes and Practice
LLINs	Long-Lasting Insecticidal Nets
mm	millimeter
MICOA	Ministry for Coordination of Environmental Affairs
MINAG	Ministerio de Agriculture (Ministry of Agriculture)
MISAU	Ministerio de Saude (Ministry of Health)
MRC	Medical Research Council of South Africa
MRL	Minimal Risk Level
NGO	Non-Governmental Organization
NIP	National Implementation Plan
NMCP	National Malaria Control Program
PCV	Packed Cell Volume
PPE	Personal Protective Equipment
PMI	President's Initiative on Malaria
SEA	Supplemental Environmental Assessment
SOAG	Strategic Objective Agreement
SUAP	Safer Use Action Plan
RTI	Research Triangle Institute
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WP	Wettable Powder

WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation Scheme

Summary and Context

This Indoor Residual Spraying (IRS) program is associated with the U.S. President's Malaria Initiative (PMI) in Africa, launched in 2005, which seeks to reduce malaria mortality by 50% in up to 15 countries by 2010. The PMI supports and complements the efforts of the Global Fund, the World Bank, and other members of the Roll Back Malaria Partnership. Angola, Tanzania, and Uganda were the first three countries selected for this Initiative, and in 2006, Mozambique, Malawi, Rwanda, and Senegal were selected for the PMI. Support of insecticide use for IRS in Mozambique and all PMI countries require a Supplemental Environmental Assessment that tiers off from USAID's *Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (IVM PEA).

The Unites States Agency for International Development (USAID) proposes to implement an IRS program for malaria vector control in Mozambique from September/October through November using carbamates, pyrethroids and dichloro-diphenyl-trichloroethane (DDT). Mozambique is characterized by perennial malaria transmission, and IRS would be used to reduce malaria incidence in the season of highest transmission. USAID will work with MISAU and MICOA before the next spray season, and annually as needed, to re-examine the need for DDT and to identify the best choice for IRS chemicals (considering safety, effectiveness and affordability in accordance with Annex B, Part II of the Stockholm Convention). So long as DDT is used with USAID support for Mozambique's IRS program, USAID will assist MICOA and MISAU in implementing activities necessary to fulfill Stockholm Convention reporting requirements.

Another aspect of malaria vector control supported by the Ministry of Health (Ministerio de Saude, henceforth referred to as the MISAU) includes Insecticide Treated Nets (ITNs) and Long Lasting Insecticidal Nets (LLINs). ITNs and LLINs are currently being distributed in Mozambique by USAID. In the long-term, larviciding and environmental management should be pursued to provide an integrated malaria vector control strategy, although these interventions are not covered by this SEA.

USAID support would be primarily for IRS operations in Zambezia Province, but may expand to include procurement of insecticides and technical assistance for other provinces. Such support would include the following components:

- Technical advice to plan the program, train field staff, and supervise field operations
- Presently, all insecticides for the IRS program are being purchased by the Government of Mozambique. Spraying equipment and adequate amounts of personal protective clothing and personal protective equipment (PPE) for spray

- Financial support for trainers and spray teams
- Financial support for storage facility renovation or purchase of containers for insecticide storage as required (see *Requirements* below and Pesticide Procedures J)
- Analysis to assess *Anopheles* susceptibility to carbamates, pyrethroids and DDT, as well as residual efficacy on various types of surfaces (see Pesticide Procedures L)
- Health education to raise public awareness and promote cooperation.
- Additional human health and environmental safety components.

A detailed Memorandum of Understanding between RTI and the Provincial Health Director of Zambezia province was developed and signed in December 2007. This MoU (provided in Annex 1) covers the period until June 30, 2008 when it will be reviewed and modified according to the changing context.

The components of the IRS program are intended to mitigate any harmful human health and environmental effects that could occur as a result of spraying with the insecticide(s) chosen. To the greatest extent possible, best professional practices will be carried out in every aspect of the IRS program. Indirect effects of the program that cannot easily be mitigated include potential use of compression sprayers and storage facilities for chemicals or methods of spraying not sanctioned by USAID that could have harmful health and environmental effects.

Required and Recommended Mitigation Measures: The Safer Use Action Plan

The Safer Use Action Plan (SUAP) puts the conclusions reached in the SEA into a plan of action, including assignment of responsibility to the appropriate parties connected with the pesticide program. Based on the specific situation of Mozambique's IRS program, the key components to the SUAP are listed below. These major components are integrated into a larger list of detailed components (**Table 1**) designed to mitigate and monitor human health and environmental impacts of the MISAU's IRS program. While this SUAP addresses the vast majority of potential human health and environmental issues that may occur as a result of the program, a public comment session indicated that the following issues are critical to the program:

- Involvement of all stakeholders, particularly the community;
- Minimization of potential collateral effects (thefts and misuse);

- Training of both sprayers and supervisors;
- Monitoring the efficacy of the spraying program.

And that, as a result, the following activities should be major focal points of the IRS program:

- Community education;
- Clear and precise information on procedures to the community in order to permit them to follow up the sprayers' actions;
- Strong social mobilization;
- Selection and recruitment of sprayers, in a very strict way, focusing on the maturity and integrity. The Minister of Health has agreed that women will not be spray operators, but should shifted to other roles, such as community mobilizers, enumerators or other positions not directly involved with spray application.
- Strict training of sprayers, supervisors, storehouse workers and drivers;
- Creation and enforcement of mechanisms of control of used insecticides in order to minimize theft and unduly applications. MINAG and MICOA, the police, as well as agricultural NGOs (including World Vision and ADRA), are all involved with the spray operations in Zambezia province to educate, monitor and enforce prevention of theft and misuse of DDT.

Requirements

1. ***Secure storage with adequate capacity for IRS insecticides and associated materials must be provided by MISAU.*** Current infrastructure is inadequate to house enough insecticide for the intended scale-up of IRS operations in Mozambique. Adequate storage, constructed or renovated according to FAO and MINAG standards, is required for support of Mozambique's IRS program. Provincial storage meets standards; district-level storage is being developed around 20 and 40 foot shipping containers on platforms with roofing and security according to FAO and MINAG standards.

2. ***Hazardous waste transport and disposal resulting from IRS operations must comply with national and international guidelines.*** Safe disposal requires an FAO-approved incinerator; however, an FAO-approved incinerator does not exist on the African continent. Thus safe disposal will require export of IRS waste materials to Europe, or storage of IRS waste materials in storage facilities until an African incinerator can be constructed or refurbished according to FAO standards. Additionally, bilateral agreements between hazardous waste exporters and importers, as well as transit countries, are required for any out-of-country disposal of IRS hazardous waste. These types of agreements need to be addressed through multi-stakeholder discussions involving MISAU, MICOA, MINAG, USAID, USEPA, FAO, WHO, and WB, among others. Currently, empty sachets and waste are being stored in the provincial warehouse waiting retrieval by the local agent for the insecticide vendor.

3. ***As part of the needs assessment process and throughout the program, provide interactive training on the logistics of IRS procurement and management.*** This training would involve IRS coordinators from the central and provincial levels and include training on insecticide selection, exercises on the actions and timing involved for IRS preparations, and adaptive management. Such training will serve to streamline IRS preparation activities in MISAU, ensure timely and effective spraying, and prevent accumulation of obsolete pesticide stocks.

4. ***Quality testing must be conducted*** for insecticides used in IRS to ensure that the appropriate amount of active ingredient is present in the formulation; this is especially necessary when generic products are purchased. Currently, a Certificate of Analysis from a WHO-approved lab facility is presented by the selected vendor to ensure quality of the insecticide product; however, additional analysis of samples from the imported insecticide is needed to ensure quality. Such analysis must be conducted by a regional lab that has satisfied, at the minimum, the USAID contractor's laboratory Quality Assurance protocol.

5. ***Ensure compliance with MICOA Environmental Impact Assessment (EIA) requirements for IRS.*** As part of the program, USAID will facilitate the development of MISAU's in-country EIA for IRS as required by MICOA EIA Guidelines.

6. ***Prohibit the practice of rinsing out the sprayer after each charge.*** Spray operators working for the MISAU in Zambezia Province were previously trained to clean the sprayer after each charge by digging a hole, dumping the remainder of the charge into it, and covering it up. The coordinator of Lubombo Spatial Development Initiative (LSDI), Ms. Elizabeth Streat, indicated that this practice is unnecessary and that sprayers only need to be dumped out/rinsed at the end of each day of spraying, not after each charge. This process has been eliminated and the "triple rinse" method instituted.

7. ***Improve the supervisory capacity in MISAU IRS programs***. Supervisory personnel are lacking. As there is only one Brigade Chief for five spray teams (as opposed to one spray team), the quality and coverage of IRS, safe use and handling of pesticides, and restriction of pesticides to use in IRS cannot be assured.

8. Increase MINAG and MICOA involvement in the MISAU IRS programs.

MINAG and MICOA participate in the Zambezia IRS campaign as described below in Requirement 9. USAID through its contractor shall promote and support as much as possible the development and the strengthening of the embryonic Working Group to discuss issues related to the IRS campaign in Mozambique.

9. ***To every extent possible, take advantage of pesticide management expertise being developed through the FAO Africa Stockpiles Program in Mozambique***. There are multiple opportunities to strengthen pesticide management-related IRS operations by working with the FAO, Ministry of Agriculture (Ministerio de Agriculture, henceforth referred to as MINAG), and the Ministry for Coordination of Environmental Affairs

(MICOA). Thus, the following activities are recommended to MISAU, with the support of USAID when appropriate:

- Work to ensure access to a pesticide quality control laboratory for IRS chemicals
- Collaborate with MINAG and FAO to carry out an assessment of minimum pesticide-storage requirements for the IRS project in Zambezia Province and other provinces in Mozambique.
- Work with the MICOA and MINAG to draft interim guidelines or regulations defining acceptable disposal options for small quantities of unusable pesticides
- Follow National Directorate of Agriculture (DINA) *Guidelines for the Registration and Handling of Pesticides* (DINA, 2003) for renovating or constructing central MISAU storehouses (e.g., Maputo, Quelimane) and as a general guideline for smaller, district-level storehouses[1]. USAID, through its contractor and in collaboration with other partners, including WHO, shall provide support to the National Directorate of Agriculture (DINA) and the Phyto-Sanitary Department (DSV) to strengthen and improve the services of registration, control, and handling of pesticides.
- Carry out training of pesticide storekeepers in collaboration with MINAG/DSV and CropLife International
- Ensure program staff, auditors and inspectors participate in training provided to federal inspectors/master trainers on technical issues involved in pesticide inspection and control, in collaboration with FAO and CropLife International.
- Follow guidelines developed by MINAG's Phytosanitary Department (DSV) and MICOA on the appropriate management of empty pesticide containers
- Follow FAO, MINAG and MICOA guidelines for disposal of unused and unusable pesticides.

10. Account for insecticide sachets according to the following procedures established by LSDI:

- At reception at provincial warehouse lot numbers of insecticide and quantities are registered on shelf inventory card.
- District requisitions are approved at the program (provincial) office where copies are maintained.
- Requisition goes to provincial warehouse where distribution takes place and signed for, based on sachet numbers.

[1] The DINA Guidelines as well as FAO's *Pesticide Storage and Stock Control Manual* need to be updated to be more suited to small-scale storage of pesticides (van der Valk 2006).

- On reception at district office, all sachets are counted and stamped with the relevant district stamp and registered on stock card.
- 5-6 can refills/day are issued to each spray operator, with their code written on the sachet. Eg M= Matutuine, 49 = no. spray operator João. On the can refills issued to João are written M49. *These sachets are signed for*.
- At the end of the day, empty and full sachets are returned and number checked against what was signed for.
- The next day all previously signed but unused sachets are re-issued and *again signed for by the relevant spray operator*.
- Spray operator performance, number of structures sprayed versus can refills used is calculated to see if there is an over or under application.
- At the end of the spray round, stock remaining = stock at start - no of sachets distributed. No. sachets distributed should be equal to no. can refills used.

11. ***In collaboration with MINAG and FAO, provide storekeepers with up-to-date training on storehouse management.*** Regardless of whether this training is provided in conjunction with FAO or not, storekeepers should be provided training on storehouse management, as described in DINA's *Guidelines for the Registration and Handling of Pesticides* (DINA, 2003).

12. ***Keep sprayer rinse-water in barrels for use at the beginning of the next spray season.*** Currently, Zambezia Province health officials are awaiting directions on how to deal with the end-of-season sprayer rinse-water; however, it is recommended that the rinse-water be saved and used at the beginning of the following spray season.

13. ***Promote PPE drop-off and washing at district storage facilities during operations.*** Current operations in Mozambique allow spray operators to wash their overalls in their home. USAID discourages this practice, as it can unnecessarily expose spray operators and their family members to insecticides, especially small children and women. USAID prefers that all PPE be returned to a central location at the end of each day, and washed at that location as needed; if spray operators return to the storage facility to clean spray cans and return used and unused sachets, this practice can certainly be instituted. If logistical circumstances cannot facilitate PPE drop-off and washing, the following instructions should be given to the spray operators:

a. Take gloves from PPE kit home; whoever washes the overalls should wear gloves during the washing

b. Dump leftover water in a pit latrine; if no pit latrine is available, dig a pit, pour the water in, and cover it up with dirt

c. Whatever tub is used for washing the overalls should be washed thoroughly with soap or dish detergent before being used for any other purpose.

14. ***Initiate monitoring of pesticides used in IRS to the extent feasible and relevant.*** According to United States Code of Federal Regulations Title 22 Section 216, "to the extent feasible and relevant, projects and programs for which Environmental Impact Statements or Environmental Assessments have been prepared should be designed to include measurement of any changes in environmental quality, positive or negative, during their implementation." Technical assistance will be provided to MICOA to assess the impact of IRS activities using DDT on the environment. This assistance is dependent on results of current environmental monitoring work being conducted in Uganda and may include training of MICOA provincial or district staff in sample site, media and size selection, methods for sample collection, and interpretation of results. Additional assistance could include procurement of sampling equipment, location of an appropriate lab facility that fulfills the USAID contractor's laboratory Quality Assurance protocol requirements, facilitation of sample analysis, and data analysis.

Policy Requirements

1. ***Before the next spray season year, USAID will assist MISAU in re-examining the need for DDT based upon the best available information and to identify the best choice for IRS chemicals*** (considering safety, effectiveness and affordability in accordance with Annex B, Part II of the Stockholm Convention). In the selection of alternatives or combination of alternatives for malaria control, human health risks and environmental implications must be considered. Viable alternatives to DDT should pose less risk to human health and the environment, be suitable for disease control based on Stockholm Convention Party-specific conditions, and be supported with monitoring data. USAID will work with MICOA and MISAU to compile and analyze available information to help inform the choice of IRS chemicals.

USAID will assist MICOA and MISAU as needed in ***implementing activities necessary to fulfill Stockholm Convention reporting requirements.***

2. Prohibit IRS in sensitive areas, including protected areas and sensitive ecosystems. Spray with care in areas where beekeeping occurs, particularly when using pyrethroids. ***Avoid DDT use in communities focused on export agriculture*** (see Table 3). ***Continue to develop mechanisms to ensure that DDT use is restricted to disease vector control (in this case malaria control).***

Recommendations

1. ***Re-form the multi-stakeholder National IRS Steering Committee.*** This Steering Committee should include relevant government representatives from MISAU, MICOA and MINAG, as well as representatives from the Food and Agriculture Organization of the United Nations (FAO), Livaningo, and any other interested international or civil society groups. The precise terms of reference should be developed by the committee itself, but can include planning and resolving issues surrounding logistics, environmental monitoring, IEC mobilization, training, and IRS operations. **Annex 2** of this SEA contains a sample Terms of Reference from the Technical Committee on IRS in Zanzibar.

The Steering Committee should increase accountability for IRS planning and implementation activities.

2. ***Do not procure or distribute pesticides and larvicides to provinces/districts that do not request them.*** Pesticide should always be ordered based on precise planning and strong communication between the central and provincial levels. Proper planning and communication will be part of the interactive training on logistics of IRS procurement and management.

The above requirements and recommendations are mapped in **Table 1**, which describes the necessary mitigation activities, parties responsible for those mitigation activities, and timeline for implementation in relation to the IRS campaign. Many, but not all, of these mitigation activities are already being conducted in the field. Upon signature of this SEA, it is understood that the required mitigation activities are to be implemented during the planning and implementation of the IRS program. Parties responsible for implementation of mitigation measures have been identified in **Table 1**.

In support of subsequent IRS campaigns supported by USAID, this Supplemental Environmental Assessment will be reviewed and revised every year as necessary to ensure the USAID support remains consistent with stipulations in Annex B, Part II of the Stockholm Convention (http://www.pops.int), Mozambique's National Implementation Plan (NIP), and Stockholm Convention party reporting requirements for DDT use, which can be found at http://www.pops.int/ddt_info/default.htm.

Table 1. Program Activities for Compliance

Mitigation Actions	Responsible Parties	Timeline (in relation to campaign)
IRS implementation and management: from procurement to campaign		
Procure only as much insecticide as will be used in the province during one year and do not procure pesticides to provinces/districts that have not made specific requests (*per Recommendation 2*)	MISAU	Pre
Procure and distribute emergency equipment to insecticide storage facilities	MISAU and RTI/Partners	Pre
Inscribe all program barrels and tubs as District Health Office property and label according to their use	MISAU and RTI/Partners	Pre
Procure and distribute barrels for progressive rinsing and wash-tubs for overall washing and personal hygiene	RTI/Partners	Pre
Conduct 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 2-4 hours after spraying • Not allowing children, pregnant women, or animals in the house until floor residue is swept outside • Destroying dead insects left after spraying (latrine) • Not plastering or painting walls after the home has been sprayed • Continued importance of using ITNs, preferable the use of LLINs	Collaboration between MISAU and RTI/Partners with input from National IRS Technical Committee	Pre
Training of spray operators in recognition of poisoning symptoms and first aid should be integrated into the 10-day training (see Pesticide Procedures E, *Any Acute and Long-Term Toxicological Hazards…*)	RTI/Partners and MISAU	Pre
Conduct interactive training in procurement, logistics and management of public health pesticides to prevent accumulation of unused and obsolete stocks (*per Requirement. 3*)	RTI/Partners, MINAG, FAO	Pre
Train spray operators, team leaders, and supervisors according to WHO guidelines	RTI/Partners	Pre
Procure and use sprayers manufactured according to WHO specifications	RTI/Partners	Pre and During
Procure and use funnels to prevent spillage of insecticide when filling sprayers	RTI/Partners	Pre and During
Procure and ensure proper use of PPE by spray operators, team leaders, and supervisors (e.g., cotton overalls, face mask, broad-rimmed hat, rubber gloves, gum boots)	RTI/Partners	Pre and During
Conduct daily sprayer maintenance	Spray operators, team leaders, supervisors, and program staff	During
Policy/technical guidance and collaboration		
Develop a strong malaria surveillance system to target IRS interventions, reducing pesticide use	MISAU, INS and RTI/Partners	

Select insecticide to minimize resistance and maximize residuality on surfaces sprayed	MISAU and RTI/Partners	Pre
Develop of protocol/implementation of measures to mitigate mosquito resistance to insecticides-- pesticide rotation or mosaicing	Collaboration between MISAU and RTI/Partners	Pre
Reconstitute the multi-stakeholder IRS Steering Committee, including the MISAU, MICOA, MINAG, and civil society stakeholders (e.g., Livaningo) (*per Recommendation 1*)	MISAU, RTI, and USAID/Mozambique	Pre
Entomological monitoring of resistance	INS and RTI/Partners	Pre and Post
Pursue an integrated strategy involving environmental management and larviciding	MISAU	Pre
Work with FAO on pesticide management issues	Collaboration between MISAU, MINAG and RTI/Partners	Pre and During
Importance of an SEA for any pesticides used in IRS will be discussed with the MISAU and MICOA staff-- online resource for conducting assessments will be provided (http://www.encapafrica.org/)	RTI and USAID/Mozambique	Pre
Ensure compliance with MICOA EIA requirements for IRS (*per Requirement 5*)	USAID	Pre
Facilitate involvement with Ministries of Agriculture and Environment (*per Requirement 8*)	USAID and RTI/Partners	Pre
Develop protocol for decision-making when environmental monitoring indicates environmental contamination as a result of IRS (suggested protocol involves the MISAU, MICOA, MINAG, and civil society stakeholder consultation at the district level)	Collaboration among members of National IRS Technical Committee	Pre
Re-examine the need for DDT based on best available information and implement activities necessary to fulfill Stockholm Convention (*per Policy Requirement 1*)	USIAD, MICOA, MISAU	Post
Conduct quality testing of insecticides		
Conduct lab-testing of insecticide to ensure quality control (*per Requirement 4*)	Included in Tender	Pre
Proper pesticide management through life cycle to minimize both pilferage and environmental contamination and maximize human safety		
(a) Transportation: Ensure safe transportation of insecticide		
Conduct training of drivers for long-distance transport of insecticide and short-distance transport during the campaign period	MISAU and RTI/Partners	Pre
Follow Guidelines for the Registration and Handling of Pesticides section on Pesticide Transportation	MISAU, MINAG and RTI/Partners	During
(b) Storage: Secure storage with adequate capacity for IRS insecticides and associated materials		
Ensure proper insecticide storage location (outside of flood-prone areas, apart from human habitation, etc. according to government guidelines), capacity, and security and in targeted districts (*per Requirement 1*)	MISAU in collaboration with MINAG and RTI/Partners	Pre
Conduct refresher training for storekeepers according to FAO and DINA guidelines (*per Requirement 11*)	MINAG and FAO in collaboration with RTI/Partners	Pre
Notify fire brigade of storage facility location and contents	MISAU	Pre

Store all insecticides, empty packaging, barrels and tubs inside storage facilities, reducing use of contaminated goods domestically	MISAU, RTI/Partners	During
Padlock and guard storage facilities	MISAU	During
(c) Use		
Discuss risks of pilferage and use of contaminated tubs/barrels, etc. during training of MISAU staff.	MISAU and RTI/Partners	Pre
Create and enforce mechanisms of control of used insecticides to minimize theft. Investigate any reports of DDT found in markets.	MISAU and RTI/Partners	Pre
Supervise spray operators (*per Requirement 7*)	MISAU and RTI/Partners	During
Insecticide sachet accounting, according to LSDI procedures and those recommended under this SEA (*per Requirement 10*)	Supervisors, storekeepers, program staff, data manager	During
Reprimand spray operators that do not follow proper procedure in all aspects of operations (e.g., handling, spraying, hygiene, cleanup)	MISAU and RTI/Partners	During
(d) Disposal: Hazardous waste transport and disposal resulting from IRS operations must comply with national and international guidelines (*per Requirement 2*)		
Convene multi-stakeholder meeting(s) to discuss the potential for bilateral agreements between hazardous waste exporters and importers	MISAU, MICAO, MINAG, USAID, USEPA, FAO, WHO, WB	Pre
Export empty DDT sachets to internationally recognized incineration facility at end of spray season (*per Requirement 2)*	Collaboration between MISAU, MINAG, MICOA, USAID, RTI/Partners, and stakeholders	Post
Environmental health and safety		
Develop program-specific guidelines for pesticide poisoning, according to guidance provided in this EA	Collaboration between MISAU and RTI/Partners	Pre
Develop and implement an environmental reporting system	USAID	Pre and During
Provide technical assistance to assess the impact of IRS activities on the environment (*per Requirement 14*)	RTI/Partners and MICOA	Pre and During
Audit IRS activities to ensure compliance with EIA and submit report to USAID MEO and IRS Steering Committee	MICOA and USAID	During and Post
Ensure that no woman is hired as Spray Operator. Develop a public education campaign on the danger of women exposure to DDT fumes and handling	MISAU	Pre and During
Prohibit cleaning/rinsing sprayers after each charge (*per Requirement 6*)	MISAU (policy), spray operators, team leaders and supervisors (implementation)	During
Prohibit spraying in flood-prone areas (when possible), areas important for agricultural production, and protected areas/sensitive ecosystems (*per Policy Requirement 2*) . Location of these areas must be discussed with District Health Offices and should be excluded from spraying during microplanning for IRS	MISAU and RTI/Partners	During
Use sprayer rinse-water from the previous spray season in the current spray season (*per Requirement 12*)	MISAU, RTI/Partners	During
Enforce PPE drop-off and washing at district storage facilities during operations (*per Requirement 13*)	MISAU and RTI/Partners	During

Conduct progressive rinsing of sprayers and PPE	Spray operators, team leaders, and supervisors	During
Prohibit spraying in homes where food and utensils have not been removed from the house, and where furniture has not been removed outside *or* moved to the middle of the room and covered with a cloth by the spray operator	MISAU (policy), spray operators, team leaders and supervisors (implementation)	During
Prohibit spraying in homes where pregnant women and sick persons are living and cannot move outside the home and stay outside the home during and 2-4 hours after spraying	MISAU (policy), spray operators, team leaders and supervisors (implementation)	During
Prior to spraying, cover furniture that cannot be moved with cloths provided by the program	MISAU (policy), spray operators, team leaders and supervisors (implementation)	During

Background and Purpose

The planned IRS program in Zambezia Province, Mozambique, is associated with the PMI in Africa, which was announced 30 June, 2005, and seeks to reduce malaria mortality by 50% in up to 15 countries (total population: 175 million) in sub-Saharan Africa by 2010 (see **Annex 3** of this SEA). This reduction will be accomplished by rapidly scaling up the following proven malaria prevention and treatment interventions in each country to reach 85% coverage of vulnerable groups (e.g., children under five, pregnant women, and people living with HIV/AIDS):

- Treatment of malarial illnesses with artemisinin-based combination therapies (ACTs)
- Intermittent preventive treatment (IPT) of pregnant women with effective antimalarial drugs, currently sulfadoxine-pyrimethamine
- Distribution of ITNs
- IRS.

In implementing these interventions, the United States will work in partnership with host governments and build on existing national malaria control plans, policies, and resources. The PMI will support and complement efforts of the Global Fund, the World Bank, and other members of the Roll Back Malaria Partnership.

Need for Action and the Preferred Alternative

Malaria is endemic throughout Mozambique, varying between mesoendemic and hyperendemic. Transmission is perennial, with peaks during and after the rainy season (December to April); however, the intensities of transmission may vary depending on the amount of rain and air temperatures observed in each year.

The coastal region is mostly hyperendemic, and the principal vectors are members of the complex *Anopheles gambiae* and *Anopheles funestus*. Regions of high altitudes and with mean annual temperatures below 21^{o}C are generally hypoendemic, with the same principal vectors, but in different proportions. Some very dry areas are considered epidemic prone. *Plasmodium falciparum* is the most prevalent parasite, responsible for about 90% of all malaria infections. *P. malariae* and *ovale* account for 9.1% and 0.9 %, respectively, of all infections.

Malaria accounts for a large part of disease burden in Mozambique and is the leading cause of morbidity and mortality. The most vulnerable groups are children under five years of age and pregnant women.

In 2000, 42% of the total patient attendances in rural and general hospitals were due to malaria (e.g., fever cases), and 61% of admissions to the pediatric ward were also due to malaria. In the same period, about 28% of hospital mortality was caused by malaria, and the case fatality rate varied between 0.4% and 7.3%. Malaria accounted for 33% of all reported deaths (verbal autopsy) in 2000. The estimated malaria prevalence for children aged two to nine ranges between 40% and 80%. It is estimated that the risk of malaria is highest between the ages of one and three, when children may experience an average of more than two episodes per year (MISAU, 2002).

Malaria is also a major problem in pregnant women in rural areas. Approximately 20% of women are parasitaemic, and among them, primigravidae (i.e., women pregnant for the first time) show the highest prevalence (31%) of malaria (MISAU, 2002).

An increase in the resistance of *P. falciparum* to anti-malarial drugs, especially to chloroquine (which varies between 15% and 40% in different sites and is the drug of choice for the treatment of non-complicated malaria), presents a big obstacle in case management, particularly at the periphery, where there is also a problem of weak capacity in clinical and laboratory diagnosis.

Mozambique's economic loss due to malaria is not really known. Episodes of illness due to malaria contribute to a loss of industrial labor, school absenteeism, and poor agricultural productivity, which is the source of potential economic gains for the majority of the rural population.

Figure 1. Alternatives Considered and Not Considered

Alternatives Considered	
IRS Program using Bendiocarb, DDT, or Lambda-Cyhalothrin WP formulations	USAID support would include an IRS program for malaria epidemic prevention in district with the following components: • Purchase of spraying equipment, and adequate amounts of personal protective clothing and PPE for spray operators, team leaders, supervisors, clothes washers, storekeepers, and other staff • Financial support for trainers, spray teams, and transport • Financial support for storage facility renovation (as needed) • Technical advisors to aid program planning, train field staff, and supervise field operations • Analysis to identify risk-prone areas • Health education to raise public awareness and promote cooperation • Additional human health and environmental safety components.
Alternatives Not Considered	
ITN Program	USAID/PMI supports ITN and LLIN programs in Mozambique. The IRS program is intended to complement these efforts.
Larviciding	Larviciding using Actellic is conducted in three provinces in Mozambique on an ad hoc basis. Scale-up of this intervention is currently not a priority for MISAU.
Environmental Management	Environmental Management is not an intervention currently supported by MISAU.
No Action	According to the IVM PEA, the no action alternative is not acceptable.

Human Health and Environmental Effects of Preferred Alternative

As a consequence of implementing the Preferred Alternative, approximately 2.2 million people in eight districts in Zambezia Province will be protected by this vector control program; USAID support for IRS may also expand into other provinces, as well. This protection will reduce the incidence of adult morbidity, miscarriages, low birth-weight,

and adverse effects on fetal neurodevelopment due to malaria. It will also reduce the incidence of malaria-related childhood anemia, complications, organ failure, and death.

The environmental effects of the preferred alternative are discussed in Pesticide Procedures G, *Compatibility of the Proposed Pesticide with Target and Nontarget Ecosystems.*

Affected Environment

Zambezia Province is divided into 17 districts, as illustrated in **Table 2**. MISAU communications with PMI staff have indicated that, for the first round of IRS supported by USAID, the focus ought to be on three main districts where operations are ongoing, to "consolidate," or shore-up, the quality of the operations. As indicated in Table 2, the districts targeted for stage one are Namacurra, Nicoadala, and Cidade de Quelimane. In the second year of support, MISAU would like sustain the operational quality achieved in stage one, and attain similar levels of quality in Milange, Mocuba and Morrumbala districts, and expand existing operations in those districts to encompass the entire district population. Stage three would expand operations to Magania da Costa and Mopeia districts. Once stage 3 is implemented, over 2.2 million people will be affected by the IRS Program.

Table 2. Population Affected Through Time

District	Population	PMI IRS Target Stage
Alto Molocue	255,123	
HR Alto Molocue	0	
Chinde	148,194	
Gilé	180,212	
Gurué	258,700	
HR Gurué	0	
Ile	246,443	
Inhassunge	120,565	
Lugela	129,251	
Maganja da Costa	289,725	3
Milange	432,723	2
HR Milange	0	
Mocuba	318,121	2
HR Mocuba	0	
Mopeia	90,291	3
Morrumbala	326,967	2
Namacurra	221,929	1
Namarroi	113,135	
Nicoadala	273,810	1
Pebane	174,685	
Cidade de Quelimane	300,311	1
HP Quelimane	0	
Target Stage 1	**796,050**	**3**

Target Stage 2	**1,873,861**	**6**
Target Stage 3	**2,253,877**	**8**
Total Percentage	**58%**	**47%**
Total	**3,880,185**	**17**

Environmental Consequences

Unavoidable Adverse Effects

Carbamates

The risk of vehicle accidents and consequent insecticide spillage is always present. Such spillage could expose humans, birds (e.g. chickens) and aquatic environments to carbamates with adverse consequences. It is also possible that the impacts of normal residential exposure of pregnant women could include neurological effects on unborn fetuses, but further research is necessary to test this hypothesis (Berkowitz, et al. 2003). Information on the combustion byproducts of carbamates can be found in USAID's *Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (IVM PEA), pages 57-58.

DDT

It is possible that the impacts of normal residential exposure of pregnant women could include a host of adverse human health impacts, including pre-term abortion, still birth, or shortened lactation (Longnecker, 2005; Damstra et al., 2004). Residential exposure to DDT may also delay neurodevelopment in children prior to the first two years of life (Eskenazi et al.; 2006).

Scientific evidence cited in WHO's *Global Assessment of the State-of-the-Science of Endocrine Disruptors* also supports the hypothesis that *in utero* exposure to DDT can cause "reduced testis and epididymis weight, reduced sperm numbers and motility, increased prostate weight and delayed puberty" in males (Damstra et al., 2004:62). *In utero* exposure may also cause hypospadias (the opening of the meatus at a higher point on the penis) in males (Damstra et al., 2004:65). Fetal mortality or adverse reproductive effects on fetuses as a result of exposure to DDT would be an unavoidable risk of the IRS program.

Recent studies also indicate the possibility of reduced male fertility as a result of occupational and non-occupational exposure to DDT used in IRS (de Jager et al., 2006).

The risk of vehicle accidents and consequent insecticide spillage is always present. Human inhalation of toxic fumes in the event of a storehouse fire is also an unavoidable

risk because open-burning of DDT "gives off irritating or toxic fumes… in a fire" (IPCS, 2004).

Pyrethroids

The risk of vehicle accidents and consequent insecticide spillage is always present. Such spillage could expose both humans and aquatic environments to pyrethroids with adverse consequences. It is also possible that the impacts of normal residential exposure of pregnant women could include neurological effects on unborn fetuses, but further research is necessary to test this hypothesis (Berkowitz, et al. 2003). This fetal exposure in the home would be an unavoidable risk of the IRS operation. Human inhalation of toxic fumes in the event of a storehouse fire is also an unavoidable risk. Information on the combustion byproducts of carbamates can be found in USAID's *Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (IVM PEA), pages 57-58.

Irreversible or Irretrievable Commitments of Resources

All financial costs of the IRS program are irretrievable. It is important to note that, after implementation of this proposal, MISAU would acquire new sprayers and other equipment that could be used in future IRS interventions with chemicals that have not undergone environmental review. The storage facilities will also contain barrels and tubs used for rinsing sprayers and cleaning protective wear. If not secured, these barrels and tubs may be pilfered and used for drinking water or food storage. According to the IVM PEA, these risks are high for all insecticides, and will be discussed during training of MISAU staff.

Environmental Impacts of the Proposed Action

The primary environmental risks of the IRS program include mortality of freshwater fish and invertebrates from improper disposal of insecticide-contaminated rinse-water, damage to apiaries due to use of carbamates or pyrethroids, mortality of birds (particularly chickens) due to use of carbamates, as well as environmental contamination from leakage of insecticide into the agricultural sector; this latter concern is particularly relevant to DDT, which is banned in Mozambique's agricultural sector through the Stockholm Convention. Training and improved supervision of spray personnel should help address this risk, and environmental monitoring should be carried out to ensure that the insecticides (particularly DDT) used in IRS does not deleteriously impact the environment.

Potential environmental impacts of the proposed action are discussed further in this SEA under the *Pesticide Procedures G., Compatibility of the Proposed Pesticide with Target and Nontarget Ecosystems*.

Direct and Indirect Effects and Their Significance

Direct Effects

USAID will directly support the use of carbamates, DDT or pyrethroids for malaria vector control in Mozambique. This support will provide protection against epidemic malaria to over 2.2 million people, primarily in Zambezia Province, and will reduce the incidence of adult morbidity, miscarriages, low birth-weight, and adverse effects on fetal neurodevelopment. It will also reduce the incidence of malaria-related childhood anemia, complications, organ failure, and death.

Indirect Effects

Through this action, USAID will be providing MISAU with spray equipment. Upon completion of the IRS program, USAID will no longer supervise the use of this capital. As a result, USAID may be indirectly supporting the activities (e.g., use of insecticides) that have not undergone environmental review.

Conflicts with Other Policies, Plans, or Controls for the Areas Under Consideration

Mozambican Environmental Requirements

The following italicized information on Mozambique's environmental laws, regulations and procedures are excerpted from Hatton et al.'s *Mozambique: Country Report on Environmental Impact Assessment* published by the Southern African Institute for Environmental Assessment (2003).

In an effort to ensure sustainable development in its drive for economic growth, the Government created the Ministério para a Coordenação da Acção Ambiental (MICOA) from the National Environmental Commission shortly after the holding of the first election in 1994.

Since 1994, MICOA has developed a legal framework for environmental management, with the following essential elements:

- *National Environmental Management Programme (MICOA 1996)*
- *Framework Environmental Act (No. 20 of 1997)*
- *EIA Regulations (Decree No. 76 of 1998), and*
- *EIA guidelines (in preparation)*

MICOA has two broad domains of responsibility:

1. *Implementing the National Environmental Management Programme and associated environmental policy and legislation, and*

2. *Coordinating with other ministries on environmental matters to integrate environmental aspects in their projects, programmes and policies.*

MICOA is in charge of regulating EIAs, which involves approving the terms of reference for EIAs, reviewing completed EIAs and implementing an audit process.

National Environmental Management Programme (MICOA 1996)

One of MICOA's first tasks was to formulate the NEMP to promote and implement sound environmental policy. The NEMP (MICOA 1996) was approved by the Council of Ministers in 1996 and contains an 'Environmental Policy', a proposal for the 'Framework Environmental Act' (subsequently passed in 1997) and an 'Environmental Strategy."

EIA is progressively becoming a key factor for approving development initiatives in the country.

Framework Environmental Act (No. 20 of 1997)

The Framework Environmental act aims to provide a legal framework for the use and correct management of the environment and its components and to assure the sustainable development of Mozambique.

Chapter 4 of the Act refers to the 'Prevention of Environmental Damage'. Under this clause, licensing of activities that are liable to cause significant environmental impacts is required. The issuance of an environmental license is dependent on an appropriate level of EIA being completed and accepted by MICOA.

A National Commission for Sustainable Development, linked to the Council of Ministers, was created in October 2000 by a provision in the Act. This Commission seeks to ensure the effective coordination and integration of sectoral policies and plans related to environmental management at the highest level.

EIA Regulations (Decree No. 76 of 1998)

The National Environmental Management Programme is the guiding policy for environmental protection and EIA is mandatory to all activities that may cause significant impacts. The Framework Environmental Act establishes the regime of the environmental licensing based on an EIA. Decree No. 76/98 of 29 December 1998 defines the EIA Regulations (comprising 19 Articles).

Article 2 specifies the range of development projects requiring some form of EIA, and is applicable to all public or private activities that may have a direct or indirect impact on the environment.

Article 3 defines MICOA's responsibilities to issue and publicise general directives on EIA procedures, approve the terms of reference, review EIAs and issue environmental licenses.

Article 4 specifies document requirements. To begin an EIA the proponent must present to MICOA a description of the activity, an executive summary of the project and the salient environmental and socio-economic features of the project location.

Article 5 defines pre-assessment procedures. All activities not covered in the Appendix of the EIA regulations but capable of causing significant environmental impact are subject to a pre-assessment by MICOA to determine the level of EIA required.

Article 6 defines the content of an EIA, which must contain at least the following

- *Geographical location of the area of influence of the activity, as well as a description of the baseline environmental situation*
- *A description of the activity and its alternatives in the planning, construction, operation and, in the case of a temporary activity, decommissioning phases*
- *A comparison of the alternatives and a prediction of the environmental impacts of each alternative*
- *Identification and assessment of mitigation measures*
- *An environmental management programme which includes the monitoring of impacts, and accident prevention and contingency plans*
- *A non-technical summary covering the main issues and conclusions for purposes of public consultation, and*
- *Identification of the team that carried out the study.*

Article 7 defines the public consultation process.

Article 8 establishes the criteria for assessing a proposed activity. These are--

- *The number of persons and communities affected*
- *The ecosystems, plants and animals affected*
- *The location and size of the area affected*
- *The duration and intensity of the impact*
- *The direct, indirect, potential, overall and cumulative effects of the impact, and*
- *The reversibility or otherwise of the impact.*

Article 9 describes the review process.

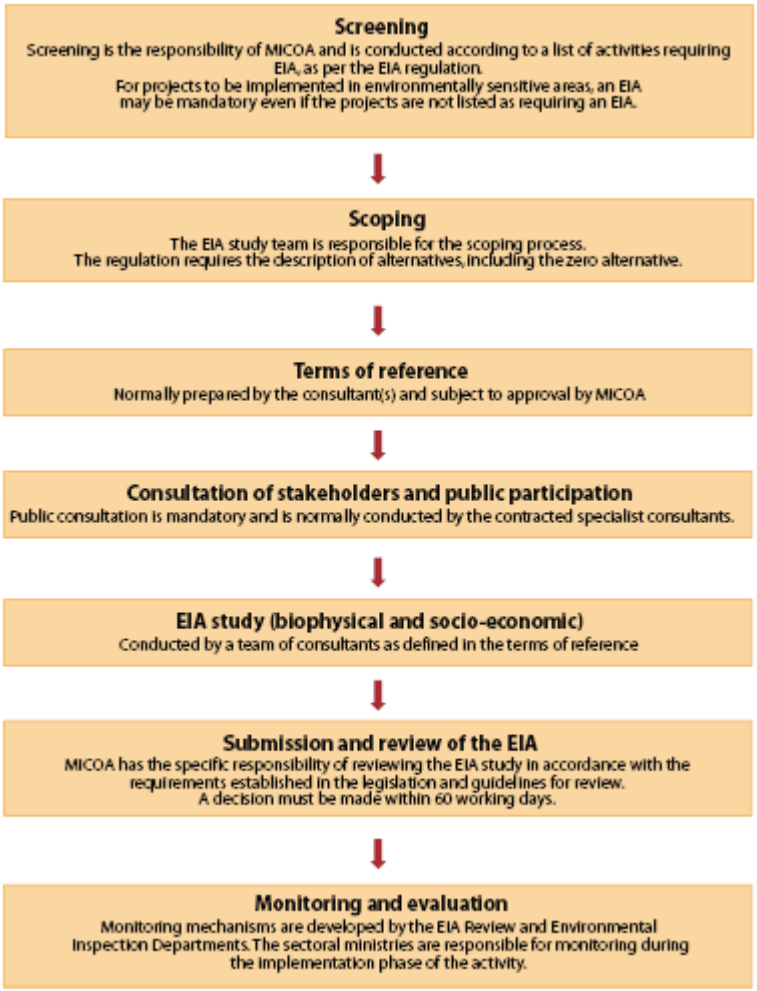
The EIA Regulations explicitly exempt listed activities that are required in order to address emergency situations arising from natural or other disasters. In these instances, MICOA is tasked with issuing instructions to direct the exempted activities (Article 2(4) of Decree 76/98). The regulations require in Article 6(2)(e) that emergency and accident identification, response and impact mitigation plans be included in the impact mitigation strategy.

An important feature of Mozambique's EIA Regulations is that the Annexure containing the list of identified activities includes both programmes and projects. While EIA is often limited to the project level in practice, more attention should be given to applying environmental assessment tools to more strategic activities like programmes and even policies, master plans and legislation.

Steps of the EIA process are described in Figure 2.

According to the Regulations, Only registered consultants, people working for a registered consulting company, or a registered consortium of companies may conduct EIA studies in Mozambique (Article 13(2)-(3)).

Figure 2. EIA Process in Mozambique



Source: Hatton et al. 2003

To-date, an EIA has not been carried out in Mozambique despite the reintroduction of DDT use in IRS in 2005. To promote compliance with Mozambique's EIA regulations,

USAID will facilitate MISAU's development of an in-country EIA that includes the information, requirements and recommendations put forth in this SEA.

Stockholm Convention Requirements

As a signatory to the Stockholm Convention, the US Government is committed to ensuring that its support of DDT in developing countries is consistent with Stockholm Convention requirements and recommendations, as well as National Implementation Plans prepared by the host countries. Thus, USAID will support the following planning, program and environmental compliance activities where it supports DDT use in disease vector control:

1. *USAID will base its support of insecticides used in disease vector control on a rational selection process* considering the insecticide's effectiveness in reducing or repelling the vector, risk to human health, the environment and the agricultural and trade sectors, acceptability in the host country, cost, the need for resistance management, and other considerations.
    - Based on insecticide resistance and disease transmission data, DDT currently is appropriate for use in Zambezia Province. See *Pesticide Procedures B* for more details. Any support of DDT use outside of Zambezia Province requires further examination as part of a rational selection process for IRS insecticides.
2. *USAID will only provide support for DDT to Parties that have notified the Stockholm Secretariat and the World Health Organization* of its production and/or use of DDT and that restrict DDT use to disease vector control.
    - As a party to the Stockholm Convention, Mozambique is obligated to notify the Stockholm Secretariat in the event that it chooses to use DDT for disease vector control. On July 8, 2005, the Minister of Health signed a letter to the Stockholm Secretariat explaining MISAU's intention to use DDT for malaria vector control.
3. *All USAID support of DDT use will follow World Health Organization recommendations and guidelines.*
    - DDT will be used in accordance with WHO recommendations from the *Manual for Indoor Residual Spraying: Application of Residual Sprays for Vector Control*.
4. *USAID will assist the Mozambican government in re-examining the need for DDT* based upon the best available information and to identify the best choice for IRS chemicals, considering safety, effectiveness and affordability in accordance with Annex B, Part II of the Stockholm Convention. The selection of alternatives or combination of alternatives for malaria control will take into consideration human health risks and environmental implications; viable alternatives to DDT should pose less risk to human health and the environment, be suitable for disease control based on Stockholm Convention Party-specific conditions, and be supported with monitoring data.

5. *USAID will regularly review and revise SEAs pertaining to DDT every year and as appropriate* to ensure that USAID support remains consistent with stipulations in Annex B, Part II of the Stockholm Convention, the Mozambican National Implementation Plan (NIP), and Stockholm Convention Party reporting requirements for DDT use.
6. *When local capacity is insufficient, USAID will assist the Government of Mozambique in conducting activities to fulfill Stockholm Convention reporting requirements.* To receive USAID support for use of DDT in IRS, the host country must demonstrate concerted effort in developing and following a National Implementation Plan (NIP) as well as reporting to the Stockholm Secretariat.
    - Mozambique has developed a draft National Implementation Plan (NIP) that has not yet been finalized and is not yet operational.
7. *USAID will support the monitoring of DDT in the environments where it is sprayed.* According to United States Code of Federal Regulations Title 22 Section 216, "to the extent feasible and relevant, projects and programs for which Environmental Impact Statements or Environmental Assessments have been prepared should be designed to include measurement of any changes in environmental quality, positive or negative, during their implementation."
8. *When local capacity is insufficient, USAID will facilitate appropriate disposal of DDT-contaminated waste* resulting from IRS operations in accordance with the Basel Convention and other relevant regional and international treaties.

Basel and Rotterdam Conventions

The Basel Convention addresses the transboundary movement, management and disposal of hazardous wastes, including waste pesticides. Transboundary movements of hazardous waste between Parties can take place only on prior written notification by the exporting state to importing (or transit) states, and the inclusion of movement documents with each shipment. In addition, Parties may not permit hazardous wastes to be exported to or imported from a non-Party except pursuant to an agreement or arrangement that stipulates provisions no less environmentally sound than those provided for by the Basel Convention. Finally, trade in hazardous waste cannot take place under conditions in which such wastes cannot be handled in an environmentally sound manner. Parties are obligated to consider illegal traffic in hazardous wastes as criminal and to notify other Party states upon prohibition of import of hazardous wastes for disposal. Export of waste pesticides may require specific compliance activities by the host-country government (USAID 2006).

The Rotterdam Convention addresses the transboundary movement of 22 chemicals, including only one chemical used for malaria vector control, DDT. Parties to the Convention must make decisions on each chemical regarding its import, abide by export limitations delineated in the treaty, and notify parties receiving exported waste according to treaty conditions. Host-country governments are responsible for complying with any

import or export treaty conditions applicable to their status as a Party or non-Party. Import or export of DDT waste products, may require specific compliance activities by the host-country government (USAID 2006).

The Government of Mozambique "accessioned" the Basel Convention on March 13, 1997, but it is not a signatory to the Rotterdam Convention. Since trans-boundary movement of the waste must occur for disposal of non water-soluble sachets, particularly DDT sachets, the Basel and Rotterdam Conventions shall be applied, taking into consideration the laws prevailing in transit and recipient countries. See *Pesticide Procedures J, The Requesting Country's Ability to Regulate or Control the Distribution, Storage, Use and Disposal of the Requested Pesticide* for more information on the need for sachet disposal options.

European Union (EU) Import Restrictions

Nations, trading groups of countries, and international institutions often define thresholds for pesticide residues present on agricultural commodities beyond which those commodities cannot be sold on the market. These thresholds are called Maximum Residue Limits (MRLs). Use of public health pesticides in the agricultural sector may increase the risk that agricultural exports exceed importing-country MRLs, reducing economic gains from agricultural exports in the host country. This is of particular concern for DDT, which persists in the environment and accumulates in animal fat. European Union MRLs are listed in **Annex 8**. The U.S. Department of Agriculture Foreign Agricultural Service (USDA/FAS) hosts an online database containing MRLs for additional countries at http://www.mrldatabase.com/. Agricultural commodities of concern for Mozambique may include those in Table 3, based on EU MRLs for DDT:

Table 3. FAO Export Profile for Mozambique. Accessed 2006.

Commodity	Quantity (Metric tons)	Value (000 USD)	Unit Value (USD)
Tobacco Leaves	11637	32022	2752
Cashew Nuts	39731	28473	717
Cotton Lint	19577	22753	1162
Sugar (Centrifugal, Raw)	43402	18152	418
Sesame Seed	12582	9005	716
Maize	11965	2113	177
Cáshew Nuts Shelled	500	1974	3948
Sugar Refined	3655	1300	356
Cottonseed	8390	937	112
Oil of Coconuts	1193	753	631
Pulses nes	2093	752	359
Molasses	10370	640	62
Tea	586	630	1075
Cake of Cotton Seed	3736	561	150
Grapefruit and Pomelos	757	521	688
Flour of Wheat	1398	462	330
Cake of Coconuts	7210	364	50
Bananas	1776	338	190
Hides Wet-Salted Cattle	277	210	758

Oil of Veget Origin nes	291	157	540

FAO Africa Stockpiles Program, MINAG, and MICOA

The FAO Africa Stockpiles Program is working with MINAG to reduce the expired pesticide stockpiles in Mozambique, as well as to build capacity to prevent further accumulation of obsolete pesticides. As the Stockpiles Program's recent Phase II Report states, "The overall objective of the mission was to carry out a review of pesticide distribution and management in Mozambique, with particular focus on the risk for future accumulation of obsolete pesticides" (van der Valk, 2005:13). The use of insecticides for malaria control poses some risk for the further accumulation of obsolete pesticides; as a result, this SEA, which is designed to counteract those risks as much as possible, has been reviewed by the Africa Stockpiles Program and has been revised to take into account concerns of those participating in the Program.

Pesticide Procedures

A. The USEPA Registration Status of the Requested Pesticide

USAID's *Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (IVM PEA) describes the USEPA registration status of the WHO-recommended IRS insecticides, as well as their EPA and WHO toxicity classes (pages 32-35).

According to the FAO Africa Stockpiles Program Mission Report for Mozambique, "all pesticides that are used in Mozambique have to be registered before their first importation and distribution, as stipulated in the Pesticide Regulation No. 153/2002. All pesticides, both of chemical and biological origin, and intended for agricultural, veterinary, public health and domestic uses are covered by this regulation" (van der Valk 2006; 27). Thus, the following insecticides are registered in Mozambique and available for use in IRS:

- Alpha-cypermethrin WP
- Bendiocarb WP
- DDT WP
- Deltamethrin WP and WG
- Etofenprox WP
- Lambda-cyhalothrin WP and CS
- Pirimiphos-methyl EC (not covered by this SEA)

Note that USAID can only procure or support the use of those insecticides registered in Mozambique.

B. The Basis for Selection of the Requested Pesticide

The chemicals used in IRS are more or less appropriate in different circumstances. The following threshold criteria must be met in making decisions on pesticides used in malaria vector control:

- Pesticide registration in the host country

As indicated in Pesticide Procedures A., all proposed insecticides must be registered for use in public health in Mozambique.

- Acceptability of the pesticide to the National Malaria Control Program

Through the Government of Mozambique tender process, MISAU procured deltamethrin and DDT for the IRS campaigns for year 2007. Enough DDT was purchased for use in 2007, 2008 and potentially 2009. Throughout the duration of USAID support for MISAU's IRS programs, USAID and its partners will work with the Government of Mozambique to choose insecticides based on an increased quantity and quality of information about their effectiveness in target areas, and will limit the amount of insecticide procured to that which is needed in the upcoming year.

- Risk to human health
  - Pesticides must be approved by the WHO and should be preferred based on their safety as described in Section 5.1.3.3. With particular regard to DDT, "viable alternatives to DDT should pose less risk to human health and the environment, be suitable for disease control based on [country]-specific conditions, and be supported with monitoring data" (UNEP 2001).

The safety of the different WHO-recommended insecticides is indicated in Table 4, and is based on a risk assessment of IRS chemicals completed for USAID's IVM PEA.

Table 4. Non-Cancer Risk Results for IRS Exposures[2]

Occupational Exposure				Residential Exposure			
Risk Below Levels of Concern	**Low Risk**	**Moderate Risk**	**High Risk**	**Risk Below Levels of Concern**	**Low Risk**	**Moderate Risk**	**High Risk**
Alpha-cypermethrin	Bendiocarb	Propoxur	DDT	Alpha-cypermethrin		Malathion	DDT
Bifenthrin	Cyfluthrin		Fenitrothion	Bifenthrin			Fenitrothion

[2] It should also be noted that the health benchmarks for DDT used in the IVM PEA are based on toxicological data that may not be consistent with more recent studies and the current state of knowledge.

Etofenprox	Lambda-cyhalothrin	Pirimiphos-methyl	Bendiocarb	Pirimiphos-methyl
Deltamethrin	Malathion		Cyfluthrin	
			Deltamethrin	
			Etofenprox	
			Lambda-cyhalothrin	
			Propoxur	

While DDT should generally not be preferred based on the human health risk presented in Table 4, the other chemicals recommended by WHO do not last as long as DDT on mud-walled homes. In this case, the malaria transmission season spans over ten months, necessitating a long-lasting insecticide.

- Risk to environment, livestock and/or agricultural trade

See Pesticide Procedures G, as well as the section on European Union (EU) Import Restrictions earlier in the document.

Beyond these four threshold considerations, technical and logistical factors must be addressed in comparing and selecting insecticides for malaria vector control. The primary factor to be addressed is:

- Vector resistance

Testing from 2000-2002 indicates that vectors are fully susceptible to all proposed insecticides in Central Mozambique, including Zambezia Province. See Pesticide Procedures F for more information on vector resistance.

Secondary factors include:

- Appropriateness of surface for spraying

DDT and carbamates should be appropriate for use on mud walls; pyrethroids will be most appropriate for western-style walls, but can also be used on mud walls if required. See Pesticide Procedures F for more information on the appropriateness of household surfaces for spraying with the different insecticides.

- Duration of effectiveness (and implications for cost)

See Pesticide Procedures F.

- Cost of insecticide

The costs of the insecticides range from approximately 4-9 US Dollars per sachet of insecticide, which is acceptable to all parties involved in the program.

Tertiary factors include:

- The need for an insecticide of a different class to prevent resistance

The use of these three insecticide classes in rotation should provide some safeguard against insecticide resistance, provided that pyrethroids and DDT are not alternated in adjacent years. This strategy has been used by LSDI in southern Mozambique.

- Major classes of insecticides used in other vector control interventions that could promote resistance

Currently, USAID is supporting scale-up of ITN use in Zambezia Province. This scale-up could promote pyrethroid and, potentially, DDT resistance in Zambezia Province. According to Casimiro et al. 2006, cross-resistance between pyrethroids and DDT through the kdr resistance mechanism has not appeared.

- Major classes of insecticides used in the agricultural sector that could promote resistance

The insecticides typically used in agriculture include pyrethroids and organophosphates, but not carbamates. Use of pyrethroids in agriculture may select for vector resistance to pyrethroids, and use of organophosphates in agriculture may select for vector resistance to carbamates.

- Host-country capacity to prevent pilferage

Mozambique does not have the capacity essential for prevention of pilferage of insecticide. As a consequence, measures will be taken to reduce pilferage such as insecticide stock management and sachet accounting according to LSDI procedures, supervision of spray operators, use of secure storage facilities with enough space to accommodate the quantities of insecticide needed, monitoring of the insecticide supply chain and accounting for transported stocks, driver training, and storekeeper training.

C. The Extent to Which the Proposed Pesticide Use is Part of an Integrated Vector Management Program

The proposed pesticide use is part of a vector management strategy that includes IRS, ITNs/LLINs, and larviciding, with the major focus on IRS and ITNs. **Annex 4** of this SEA geographically depicts the areas where ITNs are being distributed and IRS is being conducted. As of 2001, 1% to 5% of households "in selected districts" owned at least one treated mosquito net. IRS is focused on as a priority, and is implemented in 46 population centers (e.g., cities, towns, or villages). LSDI covers the urban and rural areas of six districts. As of 2001, IRS coverage by the MISAU was limited to 60% to 70% of targeted areas. Larviciding using Actellic (active ingredient: pirimiphos-methyl) is being conducted in three provinces, but is not well-organized. In its overall malaria control strategy, the MISAU promotes IEC and advocacy, IPT, and case management, as well as vector control.

D. The Proposed Method or Methods of Application, Including Availability of Appropriate Application and Safety Equipment

The proposed method of application is Indoor Residual Spraying, or IRS. IRS is a commonly used malaria vector control method that is particularly effective in preventing malaria epidemics. It is implemented by the application of residual insecticides, to which *Anopheles* female mosquitoes have been demonstrated to be susceptible, to the interior walls of houses and other structures. The insecticide remains on treated surfaces upon which mosquitoes will rest before or after taking a blood meal. Several formulations of insecticides are available for this purpose. The residual effect of the insecticide is sufficient to kill resting mosquitoes for a period ranging from three to twelve months, depending on the insecticide, the surface on which it is applied, and local conditions. The objective of the IRS program is to reduce the mean life-span of the female mosquito population below the duration required for development of the parasite life phases that occur in the mosquito and, thereby, to substantially reduce the population's ability to sustain malaria transmission. IRS is most effective in areas with seasonal malaria transmission. It is typically implemented by teams of spray operators who spray houses in at-risk localities prior to the rainy season, because heavy rains prompt increases in the *Anopheles* vector population. To be effective, IRS must attain coverage rates of at least 85% of the houses in a target area.

The spray operators who implement IRS use compression sprayers to apply a measured amount of insecticide on the interior walls of houses and structures. Insecticide is emptied from its sachet into a bucket, mixed with water, and poured into the sprayer.[3] If the insecticide product is packaged in a water-soluble sachet, the spray operator can drop the sachet into the spray can, add water, and shake the closed spray can to create insecticide solution. The sprayer is then pressurized, and the material is then applied to the interior walls of targeted houses and structures. After the day's spraying is complete, spray operators must clean the sprayer following the manufacturer's recommendations to ensure the sprayer's proper operation.

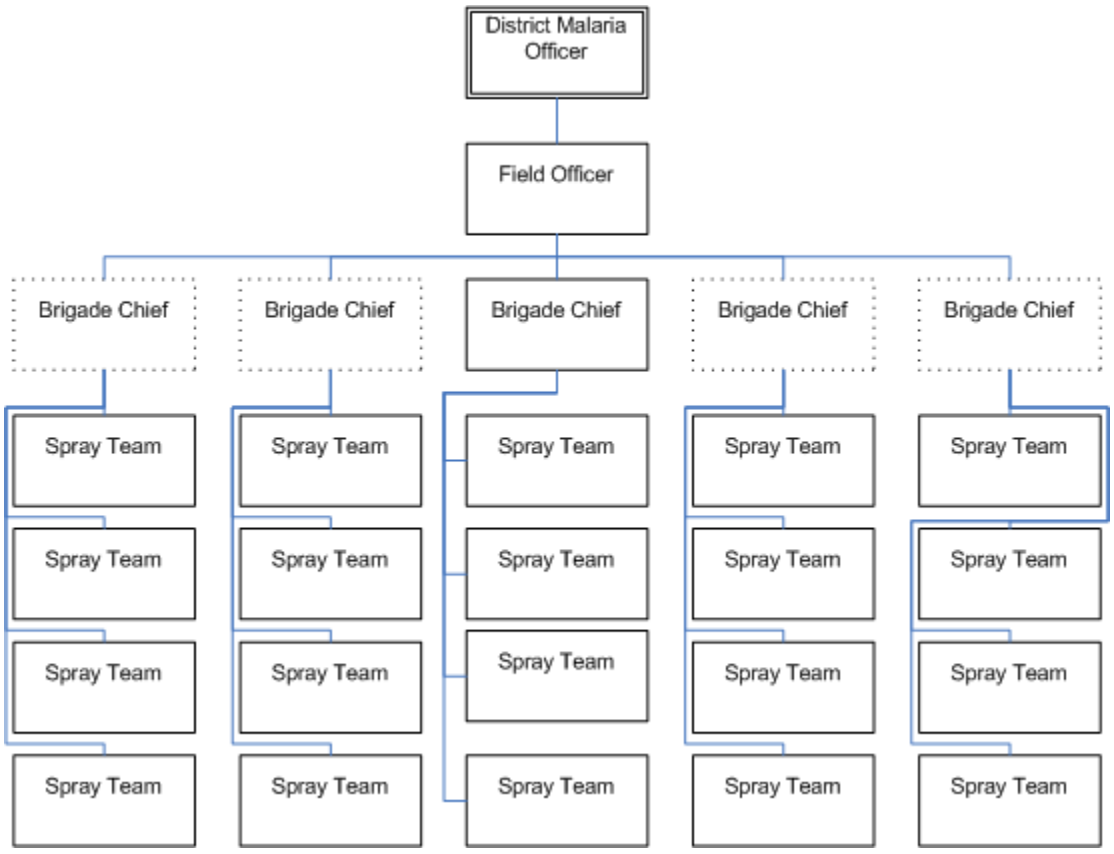
Mozambique has been using pyrethroids in its IRS operations for several years. In 2005, the MISAU started a DDT pilot program, spraying DDT in Namacurra, Nicoadala and Cidade de Quelimane in Zambezia Province. MISAU then expanded IRS to select localities in a few other districts in Zambezia, including Milange, Morrumbala, and Mocuba (see **Annex 4**).

For program start-up, three provincial and district officers were trained by LSDI in a "Training of Trainers" session. These three officers then shared the information they

[3] Currently, water-soluble sachets for DDT are not available on the market. This is due to the greater quantity of water-soluble material that is needed to package one charge of DDT, which, when dissolved, clumps and clogs spray-pump filters. Because of the volume of DDT required per charge and DDT's low water solubility, DDT is thoroughly mixed in a bucket before being poured into the spray pump to avoid clogging of spray filters with non-dissolved DDT. Until spray pump manufacturers produce spray pumps in which DDT can be mixed, this practice will be continued.

learned with three other officers, and all six worked as trainers for the spray operation. The current IRS program in Zambezia is structured in the following way:

Figure 3. Current IRS Program Structure in Zambezia



The Field Officer ensures that the district has an adequate amount of insecticide for the campaign, that the PPE is in order, and that the sprayers are maintained. The Field Officer also collects data and deals with any problems that arise (e.g., refusals).

The Brigade Chiefs supervise the spray teams. It is thought that, ideally, one Brigade Chief should supervise four spray teams; however, in Nicoadala, there is only one Brigade Chief for the 20 spray teams in the district.

Each spray team is comprised of four spray operators and one team leader, who does not conduct spraying. The team leader coordinates with local leaders and communities, supervises spray operators, works with reporting in the field, and is responsible for giving out insecticide sachets with the storekeeper. Ten sachets are given out to each spray operator per day.

Spray operators and team leaders are initially selected by community leaders, using certain criteria (e.g., behavior, seriousness, physical strength, literacy). In Nicoadala District, 700 people were initially chosen in this process, interviewed, and reduced down

to 300. Those 300 people were then trained during a 10-day period in December. The training consisted of three days of practical training on spray equipment, followed by seven days of morning spray-practice and afternoon lecture (i.e., how to care for equipment, importance of their work, and messages about malaria). Of the 300 people trained, 257 passed the training and went on to work in the spray campaign. The IRS program recruits new spray operators each year, although some spray operators have worked in previous campaigns.

The spray equipment used for the IRS program are compression sprayers that are manufactured following WHO specifications for compression sprayers for IRS operations. Each spray operator is provided with the following safety equipment, in accordance with WHO specifications:

- Long-sleeved shirt
- Pants
- Hat that covers ears and neck
- Face shield
- Rubber gloves
- Work boots
- Dust masks.

Spray operators fill out spray cards each day of the operation, documenting the location, number of rooms and households sprayed, and number of charges (amount of insecticide) used during the day. After spraying, the spray operator leaves a spray receipt with the head of household and asks them to put it in a visible place. The receipt serves as a means of cross-checking spray cards. The household is supposed to keep this receipt for the next few years so that the program can know whether the household was sprayed the previous year. Some residents do keep these receipts, but some do not.

E. Any Acute and Long-Term Toxicological Hazards, Either Human or Environmental, Associated with the Proposed Use and Measures Available to Minimize Such Hazards

Possible acute and long-term toxicological hazards have been discussed previously in this SEA under *Unavoidable Adverse Effects*. For acute and long-term toxicological hazards, see USAID's *Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (IVM PEA), Annex E.

Residential Exposure. The proposed pesticide use, the measures currently used to mitigate occupational hazards associated with insecticide use in IRS, and the recommendations for further mitigation of occupational risk are primarily mentioned in the preceding section. Although occupational exposure to the insecticide is a concern, the risk of residential exposure is also present and needs to be addressed. Typically, residential exposure is addressed by carrying out IEC campaigns to inform communities about their roles and responsibilities during the spray campaign.

Currently, MISAU orchestrates a community education campaign two weeks prior to spraying, working with local leaders in targeted communities. Prior to November 2005, the MISAU did not have a central-level official dedicated to IEC activities. The current IEC official has been tasked with developing a health IEC strategy for the country. Currently, there are no provincial or district health personnel dedicated to IEC activities; thus, when an IEC activity is being implemented, a small task force is created that dedicates its time to the campaign. District health officers were specifically tasked with explaining to community leaders the messages to give to the community, including reasons why IRS is important, and what is expected from community households. For the 2006 spray campaign, the IEC campaign was conducted from the middle to the end of January. In addition to community meetings, radio messages were also played in IRS target areas.

Municipal governments, district administrators, non-governmental organizations (NGOs), and the Anglican Church have all been active in relaying general malaria messages to communities.

If they do not do so already, the MISAU's IEC messages should also instruct IRS target community residents to do the following:

- Clear homes of furniture, cooking implements, and foodstuffs prior to spraying
- If furniture cannot be moved out of the home, then it should be moved to the center of the room and covered, if possible
- Stay outside the home during spraying and for two to four hours after spraying
- Move and keep all animals outside the home during spraying and for two to four hours after spraying
- Collect and dispose of dead insects (in a latrine) and sweep floors free of any residual insecticide that may remain from the spraying, while keeping children and animals outside
- Do not replaster or paint over the sprayed walls after spraying
- Keep using bednets for protection against malaria.

Pesticide Poisoning. The IRS program must assure that spray operators are trained to identify the signs and symptoms of poisoning and to use emergency first aid techniques. Because the treatment for poisoning is specific to each pesticide, country-specific treatment and referral guidelines must be developed based on the specific insecticides being used and the local capacity for poisoning treatment. To assure that appropriate treatment is available in the event of poisoning, the program must assure that country-specific exposure treatment guidelines are developed. Country-specific guidelines should include:

- General principles in the management of acute pesticide poisoning
- First-aid procedures and training strategy for spray operators

- Identification of appropriate treatment facilities and assurance that treatment drugs are available, provide training to local medical staff to assure that the capability to provide appropriate treatment is established, procure appropriate treatment drugs if not available, and prepare treatment guidelines for the specific country setting and pesticides being used
- Determination of referral process (transportation of exposure victim, communication with facilities)

In addition, the program should assure financial support for any medical costs incurred in managing or treating the toxic effects of exposure to insecticides used in the program.

The program country-level technical manager will be responsible for an evaluation of the capacity of local facilities to treat poisoning by the pesticides being used, including identification of a referral hospital if treatment for exposure cannot be adequately provided for by local health clinics. The institution implementing the program should assure that appropriate short-term technical assistance is provided by the program to provide necessary training of local medical staff.

Guidelines for treatment of poisoning from carbamate, DDT and pyrethroid exposure are included in Annex 5 of this SEA as well as USAID's *Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment* (IVM PEA), Annex I.

Safe Pesticide Transport. Prior to long-distance transport of the insecticide from the customs warehouse/central storage facility to a district, drivers should 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:

- For what use the insecticide is intended
- Toxicity of the insecticide
- Understanding security issues and implications of insecticide use outside public health
- Handling an accident or emergency (according to FAO standards)
- Combustibility and combustion byproducts of insecticide.

Drivers hired specifically for the two-month spray campaign period will receive the following:

- Training provided to spray operators (with the exception of sprayer operation and spray practice)
- Training on handling an accident or emergency (according to FAO standards) and a first aid kit to keep in the vehicle
- Training on handling vehicle contamination (see below).

Because vehicles are not dedicated exclusively to the IRS program, it is important to ensure that pesticide contamination in the vehicle does not have negative impacts when the vehicle is subsequently used for another purpose (e.g., food transport). Drivers will be responsible for taking care that any cloth vehicle seats are covered to prevent contamination from transportation of spray operators. To prevent pesticide runoff from vehicle washing, drivers will also be responsible for wiping the vehicle bed with a damp cloth prior to washing the exterior of the vehicle. Finally, drivers will be responsible for cleaning and decontaminating the interior of the vehicle and exterior bed at the end of the spray campaign. Drivers should be provided with gloves to wear for cleaning the vehicle. Additional requirements for pesticide transport can be found in MADER/DINA/DSV Guidelines for the Registration and Handling of Pesticides, and they should be followed.

F. The Effectiveness of the Requested Pesticide for the Proposed Use

Vector Resistance. Susceptibility tests for lambda-cyhalothrin, deltamethrin, bendiocarb, propoxur, malathion and DDT were conducted in Quelimane and 16 other sites in Mozambique from March 2000 to July 2002. These tests revealed that, in Quelimane specifically, *An. arabiensis*, and *An. gambiae* are 100% susceptible to deltamethrin and permethrin, and that *An. funestus* is 100% susceptible to lambda-cyhalothin, deltamethrin, bendiocarb, and DDT. Other tests in the central and northern parts of Mozambique revealed that *An. funestus*, *An. arabiensis*, and *An. gambiae* should be 100% susceptible to lambda-cyhalothrin, deltamethrin, bendiocarb, propoxur, malathion and DDT (Casimiro et al. 2006).

Residual Persistence. The WHO Pesticide Evaluation Scheme (WHOPES) has published the duration of effective action of IRS Insecticides (Najera and Zaim 2002), which are indicated in Table 5. Additional data on the residual persistence of insecticides can be found in the literature. For example, lambda-cyhalothrin WP was found by Brutus et al. 2001 and Sharp et al. 1993 to be effective on mud walls for at least five months. Maharaj et al. 2004 found that bendiocarb can be effective on mud walls for at six months.

Table 5. WHOPES Duration of Effective Action of IRS Insecticides.

Active Ingredient	Duration of Effective Action (Months)
Alpha-cypermethrin WP	4-6
Bendiocarb WP	2-6
DDT WP	>6
Deltamethrin WP and WG	3-6
Etofenprox WP	3-6
Lambda-cyhalothrin WP	3-6

Insecticide Quality. USAID support for IRS will require that insecticides undergo quality testing to ensure that the appropriate amount of active ingredient is present in the formulation, particularly when generic products are purchased.

Demonstrations of Effectiveness. The effectiveness of bendiocarb, lambda-cyhalothrin and DDT has been well-demonstrated in the LSDI program, which has substantially reduced malaria incidence in districts surrounding Maputo. LSDI divides its program into different administrative zones, which have each benefited substantially from IRS interventions:

> *In Zone 1, the average infection rate from all sites was 62 % in 2000, which reduced to 7.2% in June 2004. In Zone 1A overall prevalence of infection in June 2000 was 86%. This reduced to 20.8 % in June 2004. In Zone 2 overall prevalence of infection at baseline was 70% in June 2002, dropping to 29.8% in June 2004 after spraying. In Zone 3 the prevalence was 69.6% pre spraying and dropped to 58.4% after the first spray round* (LSDI Website, Update 2005).

G. Compatibility of the Proposed Pesticide with Target and Nontarget Ecosystems

Carbamates and DDT should be most compatible with their intended use in peri-urban and rural households, and pyrethroids most compatible with their intended use in urban households (or peri-urban/rural households, provided an increased dose is sprayed), with the exceptions noted in *Environmental Consequences—Unavoidable Adverse Effects*. The following paragraphs indicate the compatibility of the proposed pesticides with nontarget ecosystems.

Carbamates. Carbamates can be toxic to mammals, birds, bees, and fish and other aquatic organisms. Thus the primary concern in carbamate use for IRS would be the following scenarios:

1. ***Release of sprayer rinse-water into water bodies.*** Currently, sprayer rinse-water is re-used for the next day's operations, so the issue of release of sprayer rinse-water should not be a concern.
2. ***Release of wash-water into water bodies.*** Spray operators should wash themselves, and wash persons should wash overalls and PPE at the local or central meeting point for IRS operations. If this is not feasible, spray operators will be instructed to do the following:
    i. Never wash yourself, overalls or PPE in natural water bodies

[4] Information on Lambda-cyhalothrin CS was acquired from *Report of the Tenth WHOPES Working Group Meeting*, held from 11-14th December, 2006. The report indicated that lambda-cyahlothrin CS was effective for less than 2 months on brick and cement walls, but ranged from 3-7 months on other surfaces.

ii. Instead, collect water from the water source and wash yourself, overalls and PPE in an area far away from the water body

iii. Dump excess water in a latrine pit

iv. Thoroughly wash any washtubs that may be used with soap/detergent

3. ***Accidental spraying of apiaries (beehives).*** Accidental spraying of apiaries would kill bees residing therein.

4. ***Impacts on domestic poultry/livestock.*** There is anecdotal evidence of carbamate use resulting in the death of domestic poultry that eat insects killed by the insecticide. It is important to inform communities of this risk so they can take precautions as they see fit. When using carbamates, it is also important to educate the community about the importance of preventing children and domestic livestock from entering the household until insecticide residue from the flooring is swept out of the home/collected and disposed.

DDT. The potential impact of bioaccumulation in the environment as a result of DDT use in IRS has not been studied; thus, it is not confirmed whether the proposed pesticide use is compatible with nontarget ecosystems from the perspective of impacts resulting from bioaccumulation (e.g., eggshell thinning or other reproductive system impacts on mammals, birds, and reptiles).

In terms of toxicity, DDT is toxic to fish and other aquatic organisms. Unlike bendiocarb or lambda-cyhalothrin, DDT is not toxic to bees. Additionally, DDT is only slightly toxic to birds (although chronic exposure may lead to adverse reproductive impacts). Thus the primary concern in DDT use for IRS would be the following scenarios:

5. ***Release of sprayer rinse-water into water bodies.*** Currently, sprayer rinse-water is re-used for the next day's operations, so the issue of release of sprayer rinse-water should not be a concern.

6. ***Release of wash-water into water bodies.*** Spray operators should wash themselves, and wash persons should wash overalls and PPE at the local or central meeting point for IRS operations. If this is not feasible, spray operators will be instructed to do the following:

i. Never wash yourself, overalls or PPE in natural water bodies

ii. Instead, collect water from the water source and wash yourself, overalls and PPE in an area far away from the water body

iii. Dump excess water in a latrine pit

iv. Thoroughly wash any washtubs that may be used with soap/detergent

7. ***Runoff or flooding transporting DDT-contaminated soil to water bodies***. As spraying is currently conducted, runoff or flooding is a concern because DDT solution is deposited at each household when spray tanks are recharged. Spray operators dig a hole in which to dump excess DDT solution (from the previous charge) and rinse off the sprayers. Once the sprayer has been recharged, the hole containing the excess DDT solution is covered up with soil. Erosion of DDT-

contaminated soil could cause contamination in water bodies. Additionally, if household residents dig up DDT-contaminated soil for their personal use (e.g., on crops), the disturbance could increase the mobility of the contaminated soil during rain events. Sprayers only need cleaning once at the end each spray day, and do not need to be dumped out or cleaned when one charge is finished. The practice of rinsing out the sprayer after each charge should be prohibited.

8. ***Intentional use of DDT-contaminated soil for fishing***. In Musivi, Mozambique, soils contaminated with pesticides were used to poison fish in water bodies for human consumption. If the current practice of burying DDT solution after each charge is continued, it is possible that households would use DDT-contaminated soil left during the course of IRS operations in such fishing practices.

9. ***Use of DDT for Agricultural Purposes.*** Use of DDT for agricultural purposes must be a primary concern for the IRS program. Rigid sachet accounting procedures must be in place to detect potential pilferage from spray operators. Storage facilities must be secure at all times. A guard should be posted outside each storage facility, and all facilities should be locked—preferably double-padlocked.

Pyrethroids**.** Pyrethroids are toxic to bees, and fish and other aquatic organisms. Thus the primary concern in pyrethroid use for IRS would be the following scenarios:

10. ***Release of sprayer rinse-water into water bodies.*** Currently, sprayer rinse-water is re-used for the next day's operations, so the issue of release of sprayer rinse-water should not be a concern.

11. ***Release of wash-water into water bodies.*** Spray operators should wash themselves, and wash persons should wash overalls and PPE at the local or central meeting point for IRS operations. If this is not feasible, spray operators will be instructed to do the following:

    i. Never wash yourself, overalls or PPE in natural water bodies

    ii. Instead, collect water from the water source and wash yourself, overalls and PPE in an area far away from the water body

    iii. Dump excess water in a latrine pit

    iv. Thoroughly wash any washtubs that may be used with soap/detergent

12. ***Accidental spraying of apiaries (beehives).*** Accidental spraying of apiaries would kill bees residing therein.

H. The Conditions Under Which the Pesticide is to be Used, Including Climate, Flora, Fauna, Geography, Hydrology, and Soils

Zambezia Province, the Province primarily benefiting from PMI support of IRS, lies in the central region of Mozambique, stretching from the Indian Ocean to the Malawi border. Zambezia Province has a tropical climate, with one rainy and one dry season. The Zambezia Province capital, Quelimane, experiences peak rainfall from December through April, and temperatures in the Province range from 21 to 28 degrees Celsius (**Table 6**).

Cyclones frequent the Mozambique coast during the rainy season, and the coast of Zambezia Province has experience massive flooding in recent years. In 2001, thousands of residents in Zambezia Province were displaced by flooding.

Table 6. Average Monthly Temperature and Precipitation in Quelimane, Mozambique

	Years on Record	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Temperature °C	16	26 (avg)	28	28	28	26	24	22	21	22	24	26	28	28
Average Precipitation mm	83	1400 (total)	229	249	239	117	79	61	58	28	18	23	79	196

Source: www.qwikcast.com. Accessed June 19, 2006.

A list of the endangered species present in Mozambique can be found in **Annex 7** of this EA.

No spraying will be conducted inside the boundaries of protected areas, sensitive ecosystems, or apiaries, and no outdoor spraying will be conducted. Additionally, every effort will be made to mitigate these potential environmental impacts, including the following:

- Securing storage areas to prevent pilferage
- Supervision of spray teams to ensure proper insecticide handling and prevent pilferage
- Counting used insecticide sachets to account for proper use of the insecticide
- Re-use of sprayer rinse-water throughout the IRS program
- Supervision of persons hired to wash protective outerwear
- Environmental Compliance monitoring, and
- Environmental monitoring.

I. The Availability and Effectiveness of Other Pesticides or Non-Chemical Control Methods

Other Pesticides. The WHO-recommended chemicals registered in Mozambique include the following:

- Alpha-cypermethrin WP
- Bendiocarb WP
- DDT WP
- Deltamethrin WP and WG

- Etofenprox WP
- Lambda-cyhalothrin WP and CS
- Pirimiphos-methyl EC (not covered by this SEA)

The effectiveness of different IRS pesticides depends highly on vector resistance, house construction materials, and residual life of the pesticide on those construction materials. In Zambezia Province, resistance to the various insecticides has not been detected. Pyrethroid resistance has been detected in Southern Mozambique.

Actellic is used in three provinces in an ad-hoc manner. The effectiveness of larviciding activities in Mozambique is not known.

Non-Chemical Control Methods. Environmental management activities have not been conducted in Mozambique in any organized manner; therefore, the potential effectiveness of environmental management activities in Mozambique is not known.

J. The Requesting Country's Ability to Regulate or Control the Distribution, Storage, Use, and Disposal of the Requested Pesticide

Distribution. Insecticide is currently imported at Beira and driven to the Quelimane central store by truck; because of transportation difficulties between Beira and Quelimane, future insecticide procurements will be imported to Zambezia Province directly through Quelimane. Every two weeks, the Quelimane central store distributes insecticide to district-level stores on an as-needed basis to avoid excess stocks at the district level. Personnel, as well as insecticide and PPE, are transported from district-level stores to target villages either by truck, or by bicycle because trucks are in short supply and spray operators often ride their bicycles into the field.

This most recent spray season, the insecticide was delivered late due to delays in procurement. As a result, the spray campaign started on the day it was supposed to have ended (January 31) and did not achieve as much coverage in target areas as originally intended. The logistics of IRS procurement and management is an area that requires substantial improvement in MISAU.

Storage. Storage of insecticide is becoming a problem of great proportions in Mozambique. MISAU has procured 900 tons of DDT without securing enough secure, physically sound, facilities outside of flood plains to house the stock or the contaminated sachets resulting from IRS operations. To receive support from the PMI program for IRS, MISAU must work with colleagues in MINAG, as well as other partners to identify such facilities or construct them if they do not exist.

MISAU also procures Actellic, which is not requested by provincial staff. As a result, ad-hoc, potentially low-quality larviciding is conducted and excess larvicide remains in storage facilities. Pesticides and larvicides should not be distributed to provinces or districts that do not request them. (The use of Actellic is based on entomological surveillance from several years ago, and it is not applied to drinking water sources.)

Storekeepers are chosen based on their prior experience with storehouse work and are trained locally and on-the-job based on a manual, which could not be produced upon request, but is most likely based on Avima guidelines in accordance with conversations with central MISAU offices. The Minister of Health requested that only women be hired as storekeepers. To avoid excess stocks at the district level, the Quelimane central store distributes insecticide to the districts on an as-needed basis every two weeks. Every district where IRS is conducted has a storehouse, which is guarded 24 hours a day, 7 days per week. The storehouse manager is the only person with the key to the storehouse, and storekeepers are only employed during the spray season. It is recommended that the storekeepers receive up-to-date training on storehouse management from MINAG, based on the FAO Pesticide Storage and Stock Control Manual (FAO, 1999) and National Directorate of Agriculture (DINA) *Guidelines for the Registration and Handling of Pesticides* (DINA, 2003).

The provincial- and district-level storage facilities do not have proper equipment for handling spillages or emergencies. The following safety/emergency provisions and equipment should be available at all insecticide stores and should include the following[5]:

1. Physical Maintenance
    - Materials/labor for store-house renovation
        - Materials/labor purchase to prevent flooding of store-house grounds and interior space
        - Purchase/outfitting of containers for additional storage capacity (following FAO guidelines to the extent possible) and paying special attention to temperature control, roofing, ventilation, and prevention of flooding on grounds and interior space of containers
    - Locks and keys for storage facilities
    - Pallets for stacking insecticide and other equipment
    - Construction of securable boxes for pesticide if storehouses cannot be properly secured
2. Emergency Kit
    - 2 bags sawdust/sand
    - Empty container to contain spillage residues
    - Spade
    - Brush
    - Fire extinguisher
3. Health Kit

[5] This list may change based on recommendations from program managers in other PMI IRS programs.

- Container of water or tap (inside)
- Bar of soap
- Eyewash set
- Medical/first-aid kit

4. Stock Management Kit
    - Stock-book
    - Bin cards
    - Thermometer
    - Pens
5. Storekeeper PPE
    - Nitrile rubber or neoprene gloves
    - Rubber boots
    - Overalls
    - Goggles/face-shield
    - Vapor masks for half-face respirators with organic vapor cartridges

In the event of a leak or spill of wettable powder, absorbent sawdust, sand, or soil should be dampened and applied with a shovel over the area of the spill. The damp sawdust, sand, or soil containing spillage material should be swept or shoveled up carefully and placed in a marked container for disposal. After sweeping, which should be conducted more than once if necessary, a scrubbing brush at the end of a stick should be used to scrub down the area of the spill with water and strong soap or detergent (Ethiopia Ministry of Agriculture, 2005).

In areas where IRS is being conducted, the local fire brigade should be informed as to the location of insecticide stores and the hazards involved.

Pilferage is not seen as a major problem at the district level, although the Minister of Health recently indicated that about 20% of pyrethroids used for vector control are pilfered. IRS program staff indicated that they try to involve the administration and police for these situations. During the campaign, communities are told to notify the IRS program if someone tries to sell them pesticides from the public health sector. During the 2006 spray campaign, one sachet of DDT (670 g) was found on the market. If DDT is found outside the public health sector, the person possessing the DDT is supposed to be arrested immediately; however, current laws do not criminalize illegal pesticide trafficking, repackaging, dumping, or disposal. Such criminalization should take place to provide a basis for preventing and punishing pilferage of public health pesticides (Vera 2006).

Disposal. Because only a small dose of pyrethroids are required for IRS, pyrethroids are generally contained in water-soluble sachets that are placed directly into the spray pump,

little to no contaminated packaging should result from the use of these chemicals; however, DDT and some carbamates are not contained in water-soluble sachets due to the large doses required for IRS operations. Empty sachets will be collected by the program and exported for safe disposal (currently, empty DDT sachets are collected from the spray operators and put in empty barrels—the Province is waiting for direction from the central level on what to do with the empty sachets).

Safe disposal of contaminated sachets requires an FAO-approved incinerator; however, an FAO-approved incinerator does not exist on the African continent. Thus safe disposal will require export of IRS waste materials to Europe, or storage of IRS waste materials in storage facilities until an African incinerator can be constructed or refurbished according to FAO standards. Additionally, bilateral agreements between hazardous waste exporters and importers, as well as transit countries, are required for any out-of-country disposal of IRS hazardous waste. These types of agreements need to be addressed through multi-stakeholder discussions involving MISAU, MICOA, MINAG, USAID, USEPA, FAO, WHO, and WB, among others.

Non-contaminated insecticide packaging (e.g., boxes, paper) can be saved and returned to the manufacturer to save on future insecticide packaging costs for the program. Any cardboard packaging that cannot be re-used by the manufacturer can be open-burned; if the cardboard packaging has been heavily contaminated, it should be triple-rinsed, shredded or punctured, and taken to a hazardous waste facility. Plastic barrels must be returned to the manufacturer for re-use, used to store sprayer rinse-water for the next day's operations, or be shredded/punctured and taken to a hazardous waste facility. Under no circumstances should plastic barrels be used for water or food storage.

As already mentioned, sprayer rinse-water is re-used for the next day's operations (this is one of the major points in the operators' training). At each storehouse, there is at least one big water barrel that is used for rinsing the sprayers. These rinse-water barrels are stored just outside the actual storehouses. At the end of the program, all the rinse-water goes back to the Quelimane storehouse. Although the Province is waiting for instructions from the central MISAU office on what to do with this excess rinse-water, this rinse-water should be kept and used in the next spray season during the first day of spraying.

In the districts where USAID is supporting IRS, water used to rinse out sprayers at the end of each day must be re-used at the beginning of the next day's work to save water and reduce the potential for pollution from contaminated rinse-water by using the "progressive rinse" method, which constitutes the best practice for rinse-water re-use. With this rinse method, seven barrels/drums/containers of approximately 200-litres each 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, and so on; the seventh container is empty).

During the end-of-day cleanup, the remnants of a pump charge from the field are emptied into the first container. This will be a limited volume, which should be much less than

half of this container, as most sprayers will be returned empty from the field (the uncommon situations where more insecticide returns is where the distance to the new site makes it difficult for the team to reach to empty their sprayers. Even then, the amount coming back will be less than a full drum, or 220 liters). The spray operator will then fill the sprayer less than half-full with a cup of water from the second container, close and shake the sprayer, and dump the sprayer water in the third container. The spray operator will repeat those steps with the fourth and fifth containers, then with the sixth and seventh containers, making sure to rinse the outside of the sprayer only at the sixth container (although not *in* the sixth container).

The following day, spray pumps are filled with liquid from containers in the same sequential order: container one, then container three, then container five.

Any excess contaminated water that absolutely *cannot* be re-used (e.g. overall wash water, personal wash water), must be disposed in an evaporation tank. This is the only appropriate method for disposing of water contaminated with DDT, and is also a preferred method for disposal of pyrethroids and carbamates. Such a tank will allow the insecticide to settle out and the water to evaporate. This disposal method works well if the tank has the appropriate capacity and if the rains do not cause it to overflow. See the figure and construction details below.

Evaporation Tank Construction

The Evaporation Tank should be:

- constructed with concrete and cement
- sunk into the ground and the sides raised about 20-30cm
- sited down slope from the wash area where you do triple rinse
- 3 meters long, 2 meters wide and 20-30 centimeters deep

The Evaporation Tank should have:

- A top covered by chicken wire or fencing wire mesh
- A drain which is kept open in the rain season and when IRS is not taking place (this is to get rid of rains and to clean it easily at the start of the IRS cycle)

Key Requirements:

- Remember the evaporation tank should be constructed in such a way that it is an extension of the triple rinse arrangement so that the drips and run off and soil can be pushed to the tank
- Don't forget that the important thing is only a minimum of water should be reaching the tank. This way evaporation will not be a problem
- In places where spraying will occur in the rain season, the progressive rinse site/wash area should be protected from rainfall
- After the spraying round, all the small amount of sand that would have ended into the evaporation pan and the insecticide residue should be scooped out (during cleaning process) and placed into a bag and placed together with empty sachets
- Remember that PPE should be worn to carry contaminated water to the evaporation tank—this activity still constitutes handling of insecticide

K. The Provisions Made for Training of Users and Applicators

Training for brigade chiefs, team leaders, and spray operators is currently conducted over a 10-day period, based on the "Training of Trainers" sessions provided by LSDI. Seasonal training should be observed to ensure that it is conducted according to LSDI

guidelines and the WHO's *Manual for Indoor Residual Spraying: Application of Residual Sprays for Vector Control* (WHO, 2002). Additionally, training of spray operators in recognition of poisoning symptoms and first aid should be integrated into the 10-day training (see *Any Acute and Long-Term Toxicological Hazards…* section).

L. The Provisions Made for Monitoring the Use and Effectiveness of the Pesticide

Environmental Compliance Monitoring. According to Hatton et al.:

> *The EIA Regulations (Decree 76 of 1998) make explicit provision for post-decision follow-up by means of inspection or auditing. Article 15(1) states that –*
>
> … the Ministry for the Co-ordination of Environmental Affairs should regularly inspect and control the monitorisation [sic] and environmental management of the activity undertaken by the proponent.
>
> *MICOA can inspect and control the post-decision activities of the proponent by requesting environmental impact audits to be conducted or by undertaking inspections. The EIA review process should also consider minimum criteria for post-decision performance tracking.*
>
> Hatton et al. 2003

In addition to or in lieu of MICOA inspections, Environmental compliance monitoring will also be provided by the USAID IRS Program contractor, which will conduct a site visit during IRS operations and report to USAID on the implementation of compliance activities. This activity serves to address weaknesses in program implementation and avoid human health and environmental hazards. Throughout the duration of the program, the contractor will inspect operations and track improvement in compliance activities. The contractor will also work with MICOA as appropriate to build capacity for monitoring IRS activities in Mozambique.

Finally, as required by Automated Directives System (ADS) 204.5.4, the Strategic Objective (SO) team will actively monitor ongoing activities for compliance with the requirements and recommendations in this assessment, and modify or end activities that are not in compliance.

Entomological Monitoring. The primary function of entomological monitoring associated with vector management is to assure that interventions are effective. Such monitoring is essential for IRS, is currently being conducted in the program, and will be expanded as a result of USAID/PMI support.

Determine vector susceptibility to available insecticides. Susceptibility studies detect the presence of individuals in the vector population that are physiologically resistant to the insecticide being tested. For IRS, susceptibility studies can be conducted by using WHO test strips or CDC bottle assays on adults caught in the wild or adults reared from immature larvae. Although the CDC bottle assays have the advantage of testing a sample

of the same chemical batch being applied, the WHO test strips enable more comparability across countries and time. In addition to the above "in vivo" resistance information, it is also possible to collect large numbers of the vector species for analysis to determine the frequency of genetic markers that code for pesticide resistance in the local vector population. This analysis, however, should not be used as a substitute for "in vivo" resistance analysis.

Verify that the insecticide was applied properly and had an immediate effect. For IRS, routine wall bioassays are used to verify there is sufficient residual pesticide on the walls of sampled structures to kill vector mosquitoes, and to monitor the loss of residual efficacy over time.

Determine the geographic and temporal distribution of vector populations. To target areas where vector control for malaria is needed, it is necessary to determine where malaria transmission occurs and the length of the transmission season by establishing when populations of adult vectors are present. This is currently done in several provinces using window exit traps, and USAID/PMI support will expand this monitoring.

Measure the impact of the intervention on the vector population and/or malaria transmission intensity. Several different techniques are used to monitor the vector population and/or the frequency and infectivity of vector biting. In general, the intention is to determine whether the vector management program has substantially reduced the vector population or survivorship, as indicated either by a reduction in the number of mosquitoes that can be collected, a reduction in mosquito biting, or, as detected through mosquito dissections, the proportion parous (the proportion that have laid at least one batch of eggs). Window exit traps are currently used to monitor the vector population and determine the frequency and infectivity of malaria transmission; this activity will expand as a result of USAID/PMI support.

Monitoring Environment. According to United States Code of Federal Regulations Title 22 Section 216, "to the extent feasible and relevant, projects and programs for which Environmental Impact Statements or Environmental Assessments have been prepared should be designed to include measurement of any changes in environmental quality, positive or negative, during their implementation." Technical assistance will be provided to MICOA to assess the impact of IRS activities using DDT on the environment.

Public Comment

MISAU and USAID convened a public comment meeting for this SEA in Zambezia Province on April 26, 2007. The public comment meeting consisted of an English presentation accompanied by Portuguese translation and a Portuguese power-point and a subsequent question-and-answer and community feedback session. The following sections describe the announcements made prior to the meeting, the meeting notes, and

meeting attendees. Major conclusions from the meeting have been incorporated into this assessment as focal points upon which the program should concentrate.

Announcement

The following announcement for the Public Comment Meeting was placed in the newspaper NOTÍCIAS and on Radio Moçambique-Zambézia for April 21, 23 and 24, 2007.

AGÊNCIA AMERICANA PARA O DESENVOLVIMENTO INTERNACIONAL

(USAID)

Anúncio Público referente à Revisão do Estudo de Impacto Ambiental promovido pela USAID no âmbito do Programa de Pulverização Intradomiciliária para Controlo do Vector da Malária em Moçambique

A Agência dos Estados Unidos para o Desenvolvimento Internacional (USAID), em estreita colaboração com o Programa Nacional de Controlo da Malária do Ministério da Saúde, está a preparar um "Estudo de Impacto Ambiental para o Programa de Pulverização Intradomiciliária para o controlo do vector da Malária em Moçambique com recurso a diversos insecticidas, incluindo Carbamatos, DDT e Peritróides". Numa primeira fase o apoio da USAID será concentrado na Província da Zambézia e se traduzirá no seguinte:

- Aquisição de insecticida (Carbamatos, DDT e Peritróides), equipamento de pulverização e quantidades adequadas de meios, equipamentos e roupas de protecção individual, quer para os rociadores, como para o pessoal de supervisão;
- Apoio financeiro para formadores e rociadores;
- Apoio financeiro necessário para reabilitação de instalações de armazenagem;
- Assessores técnicos para a programação, formação de pessoal de campo e de supervisão das operações no terreno;
- Levantamentos e análise da susceptibilidade do mosquito aos insecticidas usados na Província da Zambézia, assim como da eficácia dos insecticidas nas diferentes tipologias construtivas das residências;
- Educação em saúde para o aumento da consciência da população e promoção da cooperação;
- Outras componentes relativas à saúde pública e segurança ambiental tal como é referido no estudo preliminar de Impacto Ambiental.

O Estudo de impacto ambiental deverá ser revisto anualmente de modo a assegurar que o apoio da USAID se mantenha consistente com o que é estipulado no Anexo B, Parte II da Convenção de Estocolmo (http://www.pops.int), Plano Nacional de Implementação em Moçambique, e de acordo com a Convenção de Estocolmo no respeitante aos requisitos de informação para o uso do DDT como se pode constatar em http://www.pops.int/ddt_info/default.htm.

A Versão Preliminar do Estudo de Impacto Ambiental (EIA) está disponível para consulta pública a partir da USAID. A USAID solicita a quem esteja interessado que apresente comentários ao documento nomeadamente durante uma reunião pública a realizar-se no dia 26 de Abril de 2007 a partir das 8:30 horas na Sala de Conferências do Hotel Chuabo, Quelimane. O MISAU e a USAID tomarão igualmente em consideração os comentários que venham a ser recebidos até ao dia 27 de Abril de 2007.

Contactos para informações adicionais:

USAID Moçambique

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Ministério da Saúde:

Dra. Ivone E. Rungo, Directora, Programa Nacional de Controlo da Malária, Ministério da Saúde, Av. Eduardo Mondlane, 789, r/c Maputo Moçambique; Telefone: 258 823149180; endereço de email: ierungo@yahoo.com.br

Public Comment Meeting Summary

Introduction

On the 26th April 2007, at 09:00 o'clock, there was a Meeting of Public Awareness on Inter-Residential Spraying (IRS) at Chuabo Hotel, in the city of Quelimane, Zambézia Province, for malaria control. The meeting was facilitated by Dr. Elisabeth Streat, who started the meeting by welcoming the participants and presenting team work members such as the objectives of the program.

Melanie Biscoe of RTI, initiated her presentation mentioning the three aims of the meeting, namely, a study on the components of the Program, the assessment on how the program affects Zambézia Province and on the importance of a quality program, as well as the public awareness on the program by the fact that the PMI needs a return on environmental evaluation.

Mr. John Chimumbwa was invited to make a presentation on the IRS's basic concept in Mozambique and speak of PMI's support to MISAU and the importance of quality in the program.

He mentioned the growing concern in African countries over the need to control malaria, adding that in the search for support for the purpose, the response came from the President's Malaria Initiative (PMI), which contemplated in its program a support to Mozambique, among other African countries.

Mr. Chimumbwa noted that the intra-residential spraying will only be efficient if the measures taken are in strict collaboration with the population and the coverage area is about 85%. He called on the attention to the fact that this program is long term and as such its efficiency will not be visible in only one season. He also stressed that it is necessary a coordinated work and in an integrated way, so as to prevent malaria from returning, noting that besides IRS, it should also be included the use of mosquito nets.

An adequate mobilization of the population and the correct information on measures that should be taken immediately for malaria prevention and treatment are key factors for the success of this program. This presupposes an efficacious and efficient communication campaign in this sense before spraying and the use of mosquito nets should be continuously promoted.

Following Mr. Chimumbwa's presentation, Ms. Melanie addressed once again the gathering, explaining why the US Government supports and funds the IRS program in PMI, which demands an environmental evaluation of the program.

It also demands that PMI obey the laws and regulations of the Mozambican Government, and that is why one of the purposes of the evaluation is to provide details on how those laws and regulations should be followed. She said that the primary objectives of the evaluation were to ensure the community's good health and security during the implementation of the program and minimize the harmful environmental impacts, with this form being successful in terms of guaranteeing the reduction of malaria incidence.

Ms. Melanie raised other issues related to the efficiency of insecticides used in malaria control, having referred to the duration of insecticide activity along the year. Still on the insecticides, they should be registered in MINAG and the insecticide families should be sustained by the environmental evaluations in detriment of singular chemicals.

Regarding the general vision of operational demands, she underlined the aspects such as re-use of water, security measures to guarantee the use of insecticides only within the program and public health, the storage and safe removal of insecticide packages the programs of education, information and partnership of the population, the sprayers' security measures, on the uncertainty of the quantity of insecticides in the environment, on the measures of prevention and action in case of emergency, the action in terms of agricultural regulations on pesticides in Mozambique, in terms of the Stockholm Convention, the non-spraying or around areas environmentally sensitive or with agricultural exports (DDT). Ms. Melanie ended her intervention recommending the establishment of a Technical Committee for the Supervision of IRS and an increase in the coordination of the purchase of insecticides and larvicides.

Debate

The session having been opened, one of the participants questioned the identification of areas where spraying is under way and the responsibility of IRS.

In response, it was clarified that at provincial level it is the program coordinator and at district level there are people carrying out the activities of the National Health System, who are working for the program.

It was also explained that spraying is taking place in 6 districts of Zambezia Province, namely:

- Nicoadala
- Namacura
- Mocuba
- Morrumbala
- Milange (only at the headquarters)

Another aspect raised was regarding security, in terms of bags containing insecticides, since the local farmers are only concerned over packages to store their production of maize, groundnuts or any other agricultural product, without worrying over what the container had, whether its contents were residual or not.

It was then explained that insecticides come in small bags and each bag is equivalent to a cargo. Each day, the sprayer takes the necessary cargos for spraying, upon signing a document to confirm the product taken. At the end of the day, he returns the remaining product if there is any and he also returns the empty cargos to be placed in special drums for posterior destruction or throwing away in chemical waste, this being one of the main control mechanisms.

It was also explained that at the level of warehouses, where insecticides are stored, there are warehouse workers who control the quantity of insecticides that they give to each sprayer and they do so through a record file (with the sprayer's number) where they record what the sprayer took. There is also a file for the control of the shelf and files for the control of the storage within the warehouse.

In parallel to the aspects above mentioned, there are community education campaigns that stress the use of insecticides only for public health purposes. The communities are encouraged to report to the authorities over the illegal sale of the insecticides. Campaigns are under way in the cities of Maputo, Matola and Gaza Province, for the identification of illegal vendors of insecticides and control measures are anticipated. This process takes place through supervision teams.

It was also stressed that the training of supervisors and their responsibility are of a vital importance for the program's success.

The monitoring component is included in the program and it should count on the support of the government and nongovernmental organizations for the identification of failures that may occur within it.

One of the ways to monitor the sprayers' work is through bio-trials made by entomologists, which consists in the introduction in the sprayed environment of a laboratory mosquito and assess its behavior. Other ways consist in the evaluation of insecticide residue along the wall and in the community surveillance (the amount of water to be added to the insecticide is monitored by the community since it is the one that supplies it).

An issued was raised linked to contamination through a possible theft and re-use of packages for agricultural purposes or through a possible purchase of insecticides for the control of pests in agriculture and it was questioned what management should be made should that occur.

On this question, the response was that the application is the key of success to this program. It is a general responsibility both of the community and the people involved in the program to protect the environment. All the sectors should take part in the program in an integrated way. The quantity of insecticides within the houses is enough to kill the malaria vector and in minimum quantities in such a way that it does not permit much possibility of spreading through the environment. However, if contamination occurs, it means that something went wrong in the process.

In this point, it was stressed the need for a tight control in the stock-taking and return of the insecticide and in the correct storage of residuals, including the washing of containers that may be correctly stored.

In the past, DDT was banned and there was a considerable controversy over the issue. It has been reintroduced, with talk of the effects of environment, should it be misused and of the role of sprayers in the program, allied to a sound information campaign among the

communities. Thus, it was questioned the effectiveness of the program in its communication and monitoring campaign.

In order to answer this question, it was explained that the strengthening of the social mobilization which is under way is fundamental both for the use of DDT and of other insecticides and it was called on the attention on the need to be of a permanent nature. This mobilization starts with the sprayer who mobilizes door to door.

Ninety five percent of the package for social mobilization is destined to radio campaigns which are the communication means that reaches most of the population. This mobilization should also count on the involvement of other sectors. Basically, the communication instruments used are radio, a briefing with community leaders, meetings with multi-disciplinary teams and the use of megaphones in communities.

All this should be allied to a good performance of supervisors, sprayers, storehouse workers and drivers.

Still within the context of training, in order to improve communication and the movement of information, religious leaders are being trained in order to take part in the dissemination of information relevant to the program.

Taking into account the fact that the spraying program is a long term one, it was questioned the measuring of its efficacy. In response, it was explained that this measuring is very technical and it may be done in the following way:

- Measuring of the quality of insecticide in the laboratory
- Measuring of the quantity of insecticides in sprayed walls
- Use of mosquitoes in laboratories
- Analysis (monitoring) of the mosquito population to see whether they are not creating resistance. Should there by resistance, the insecticide should be changed.

However, in conformity with what was said earlier, the key for the program's success is communication with the population.

The constant monitoring is also very important for the identification of the reason for the program's inefficacy, which may be caused by the community's behavior or in the creation of resistance by the mosquitoes. It was also stressed the need to combine several ways of intervention (nets, treatment, malaria medicine and insecticides).

Another relevant issue was in which way will be the control in order to avoid the diverting of insecticides for agricultural purposes, since it is a common practice the theft of stored products.

For this case, it was stated that it was impossible to guarantee 100% theft control. What can be done is to try and minimize it through a tight control on the daily use of insecticides and community mobilization for the notification on the illegal use of insecticides. The communities should be well informed, so as to avoid the incorrect use of the prevention means.

MISAU is attentive to the risks emerging from the program and searches to minimize its effects through education/information to the communities.

There was also a question on how the control of emergencies would be done. In this point, it is being created a decentralization of the capacity of emergency management of the exposed populations.

As regards the recruitment and selection of sprayers, it was stressed the need to take into account its maturity and integrity, besides physical capacity, education and training. This recruitment should be strict in order to obtain a positive result. It was mentioned that a study is under way for the recruitment of demobilized soldiers in order to get advantage of their military training, since they already have a habit of discipline and obedience to rules. Therefore, the strictness of behavior, as well as the maturity necessary for the program is guaranteed.

In response to the question on the quantity of DDT that is being imported, particularly for Zambezia, the Zambezia Provincial Health Director informed that in the first stage it was imported 430 tones which will be used throughout the country, 80% of which were applied in Zambézia. For the next season, it is anticipated the import of 900 tones, 120 of which for Zambézia.

Replying to a question also related to the existence or not of obsolete insecticides, it was also mentioned that there is DDT that was not used, which is stored in Zambézia and Maputo Provinces and are still up to date.

So far, there has been no case of expiry of insecticides. The material used in the first campaign is also stored because the mechanisms for its destruction are not clear, and less clear is the responsibility of the first supplier in this aspect. Regarding outdated DDT, Ms. Melanie said a case was recorded in Angola. However, the monitoring of the project worked in accordance with what was stipulated and the DDT was not used, and USAID sought to have it returned to the supplier, according to the rules.

The program has the concern of defining mechanisms for the management and destruction of obsolete chemicals. DDT is being imported for the next phase and it will be done in a phased way, so as to avoid the storage of huge quantities and its deficient management.

Conclusions

In order to finalize, the following aspects were reminded to the participants:

- It is necessary the involvement of all stakeholders, particularly the community.
- It is necessary to minimize to the maximum the collateral effects (thefts and misuse).
- It is imperative the training, not only for sprayers, but also supervisors.
- The creation of possible mitigation measures for the malaria incidence.

To summarize, from this meeting and the participants' intervention, it was clear that the program should take into account the following aspects:

- Community education is essential for the program;
- Clear and precise information on procedures to the community in order to permit them to follow up the sprayers' actions;
- Strong social mobilization;
- Selection and recruitment of sprayers, in a very strict way, focusing on the maturity and integrity;
- Strict training of sprayers, supervisors, storehouse workers and drivers;
- Creation and enforcement of mechanisms of control of used insecticides in order to minimize theft and unduly applications.

The discussion was thus closed, as it was clear that all the themes for debate defined by the public and prepared by taskforce exhausted.

Meeting Attendees

Attendee	Affiliation
Antonio Sequeira	Agrifocus
Jose Martins	USAID
Casimiro	PSI
Maielle Helman	PSI
Brian Hilton	World Vision
Rodollo Henriquez	ADRA
Eva de Carvalho	WHO
Antonio Augusto	DPS 2
Juliette Morgan	PMI/CDC
Camilien J.W. St. Cyr	USAID/SA
Michael Coleman	LATH
Africa Soeiro	Austral
Antonio Zefanias	Journalista D. Zambezia
Ivone Rungo	MISAU
Elizabeth Streat	MRC/LSDI
Abu Saifodine	USAID
David Jamisse	Crown Agents
Alexandra Viola	Austral
Melanie Biscoe	RTI
John Chimumbwa	RTI

Preparation Methodology and Acknowledgements

The contents of this SEA are based on direct communication with MISAU, WHO, Agrifocus Limitada, FAO, PAN UK, Livaningo, Neoquimica, Bayer Environmental Science, the National Institutes of Health Mozambique, UNICEF, the Zambezia Provincial Health Office, the Nicoadala District Health Office, and the Lubombo Spatial Development Initiative. Individuals from these organizations and institutions graciously provided information on pesticide and vector control practices currently being conducted in Mozambique to a team consisting of:

Ms. Melanie Biscoe	Environmental Scientist, RTI International
Ms. Elizabeth Streat	Medical Research Council (MRC) South Africa
Dr. Abuchahama Saifodine	Health Team Leader, USAID/Mozambique
Mr. Camilien Saint-Cyr	Regional Environmental Officer, USAID
Dr. Walter Knausenberger	Regional Environmental Officer, USAID
Dr. Titus Angi	Health, Population and Nutrition Specialist, USAID/Mozambique
José Martins	Mission Environmental Officer, USAID/Mozambique

Research for this SEA was conducted over a 10-day period from April 2 to April 13, 2006. Additionally, government documents concerning pesticide use, the environment, and malaria control were reviewed and incorporated into this SEA. On April 26, 2007, MISAU and USAID convened a public comment meeting in Zambezia, Mozambique. This SEA was then revised to accommodate feedback from the meeting.

Bibliography

Berkowitz, G.; Obel, J.; Deych, E.; Lapinski, R.; Godbold, J.; Liu, Z.; Landrigan, P.; and Wolff, M. 2003. Exposure to indoor pesticides during pregnancy in a multiethnic, urban cohort. *Environmental Health Perspectives.* 111:1; 79-85.

Brutus, L.; Le Goff G.; Rasoloniaina L.; Rajaonarivelo V.; Raveloson A.; and Cot, M. 2001. Comparison of lambda-cyhalothrin and DDT house-spraying for malaria control on the western slopes of Madagascar Highlands. I-Entomological Study. Parasite-Journal de la Societe Francaise de Parasitologie. 8:4; 297-308.

Casimiro, S.; Coleman, M.; Hemingway, J.; and Sharp, B. 2006. Insecticide Resistance in *Anopheles arabiensis* and *Anopheles gambiae* from Moazmbique. *Journal of Medical Entomology*. 43:2; 276-82.

Casimiro, S.; Coleman, M.; Mohloai, P.; Hemingway, J.; and Sharp, B. 2006. Insecticide Resistance in *Anopheles funestus* (Diptera: Culicidae) from Moazmbique. *Journal of Medical Entomology*. 43:2; 267-75.

Damstra, T.; Barlow, S.; Bergman, A.; Kavlock, R.; and Van Der Kraak, G., ed. 2004. *Global Assessment of the State of the Science of Endocrine Disruptors.* International Programme on Chemical Safety. Geneva, Switzerland: World Health Organization. http://www.who.int/ipcs/publications/new_issues/endocrine_disruptors/en/

de Jager, C.; Farias, P.; Barraza-Villarreal, A.; Avila, M.; Ayotte, P.; Dewailly, E.; Dombrowski, C.; Rousseau, F.; Sanchez, V.; and Bailey, J. 2006. Reduced seminal parameters associated with environmental DDT exposure and p,p '-DDE concentrations in men in Chiapas, Mexico: A cross-sectional study. *Journal of Andrology*. 27:1; 16-27.

Eskenazi, B.; Marks, A.; Bradman, A.; Fenster, L.; Johnson, C.; Barr, D.; and Jewell, N. 2006. In Utero Exposure to Dichlorodiphenyltrichloroethane (DDT) and Dichlorodiphenyldichloroethylene (DDE) and Neurodevelopment Among Young Mexican American Children. *Pediatrics*. 118:1; 232-41.

Ethiopia Ministry of Agriculture and Rural Development/Prevention and Disposal of Obsolete Pesticide Stocks in Ethiopia—Phase II Project. 2005. *Pesticide Registration, Management and Prevention of Accumulation of Obsolete Pesticides: Training for Regional Pesticide Inspectors and Crop Protection Experts, December 6-8, 2005*.

Food and Agriculture Organization of the United Nations (FAO). 2004. Draft Guidance Document: *The Selection of Waste Management Options for the Disposal of Obsolete Pesticides and Contaminated Materials*.

Food and Agriculture Organization of the United Nations (FAO). 1999. *Pesticide Storage and Stock Control Manual.*

Hatton, J.; Telford, S.; and Krugmann, H. 2003. *Mozambique: Country Report on Environmental Impact Assessment*. Southern African Institute for Environmental Assessment

International Programme on Chemical Safety (IPCS). 1990. *Health and Safety Guide No. 38: Cyhalothrin and Lambda-cyhalothrin Health and Safety Guide.* (UNEP/ILO/WHO).

Longnecker, M. 2005. Invited Commentary: Why DDT Matters Now. *American Journal of Epidemiology*. 162:8; 726-728.

LSDI Website. 2005. *Update 2005*. http://www.malaria.org.za/lsdi/Update/Update2005.html

Maharaj, R.; Casimiro, S.; Mthembu, S.; and Sharp, B. 2004. The Residual Life of Bendiocarb: A Field-Based Evaluation from Mozambique. *Journal of Medical Entomology*. 41:1; 130-32.

Najera, J. and M. Zaim. 2002. *Malaria Vector Control: Decision Making Criteria and Procedures for Judicious Use of Insecticides*. World Health Organization Pesticide Evaluation Scheme (WHOPES).

Sharp, B., et al. 1993. Assessment of the Residual Efficacy of Lambda-cyhalothrin 2. A Comparison with DDT for the Intradomiciliary Control of Anopheles Arabiensis in South Africa. *Journal of the American Mosquito Control Association*. 9:4; 414-20.

van der Valk, H. 2006. *Mission Report: Prevention and Disposal of Obsolete Pesticides in Mozambique—Phase II* (GCP/MOZ/080/JPN). Technical mission to support the project's Prevention Component. 5-26 October 2005. Food and Agriculture Organization of the United Nations.

Vera, E. 2006. *Republic of Mozambique: Prevention and Disposal of Obsolete Pesticide Stocks in Mozambique (Phase 2)* (GCP/MOZ/080/JPN). Food and Agriculture Organization of the United Nations.

World Health Organization (WHO). 2007. *Report of the Tenth WHOPES Working Group Meeting.*

World Health Organization (WHO). 2004. *International Chemical Safety Cards: DDT*. (WHO/ILO/UNEP).

World Health Organization (WHO). 1997. International Chemical Safety Cards: Lambda-cyhalothrin. (WHO/ILO/UNEP).

World Health Organization (WHO). 2002. *Manual for Indoor Residual Spraying: Application of Residual Sprays for Vector Control* (WHO/CDS/WHOPES/GCDPP/2000.3).

Annex 1: Memorandum of Understanding between Research Triangle Institute and Direccao Provincial de Saude

MEMORANDUM OF UNDERSTANDING

This Memorandum of understanding is made

Between

Research Triangle Institute International (RTI)

And

Direccao Provincial de Saúde (DPS), Zambezia Province, Moçambique

The Memorandum of Understanding (hereinafter "MOU") describes the collaboration between:

- RTI through it's Mozambique Indoor Residual Spraying (IRS) Office, located at Avenida Antonio Jose de Almeida, noº 109, Barrio da Sommersheild, Maputo, Mozambique, and
- DPS, Zambezia located Aveninda 1st Junho, Travissa 1st Junho, P.O. Box 50 Quelimane, Tel/fax 24214424.

BACKGROUND

The Zambézia IRS program was initiated in 2006 in the provincial capital of Quelimane and in all the villages within the districts of Nicoadala and Namacurra. Spraying was expanded to include the districts of Mocuba, Milange town and Morrumbala in 2007/2008. The DDT spraying program will cover an estimated population of 1.69 million if 100% coverage is achieved.

The MoH views IRS as one of its major malaria control measures and plans to scale up coverage to 40% of the country's population in 2007 and to 45% by 2008. Nationally, spraying is scheduled to take place in all or part of 46 districts in 2006-2007 and efforts will be made to increase coverage, quality, and timeliness of spraying in areas where it is currently targeted. To achieve the full impact of IRS, spraying campaigns must be carefully planned, initiated within one to two months before the rains (the major malaria transmission season), and conducted with a well-trained and supervised staff who have strong logistic support.

The MoH plans to invest heavily in the IRS program and has purchased 900 tons of DDT for IRS campaigns in the entire country. USAID/Mozambique has FY06 and FY07 funding specifically to support IRS. These funds will be used to finance commodities, technical assistance and local costs of the MOH IRS component in Zambezia Province for its 2007 IRS campaign.

OBJECTIVES OF THE MOU

The objective of this MOU is to outline the roles and responsibilities of DPS and RTI in Mozambique during the 2007-2008 IRS Campaign. This is a targeted spray campaign that will cover 6 districts in Zambezia Province (Quelimane city, Nicoadala district, Namacurra District,, Morrumbala, Mocuba and

Milange administrative district) . Through USAID support, RTI will provide protection for the population of 1.69 million with 85% of houses being targeted for spraying during the IRS campaign.

ROLES AND RESPONSIBILITIES

Each party will have respectively the following roles and responsibilities:

Research Triangle Institute International (RTI) agrees to:

Pre-campaign:

☛ Conduct the Environmental assessment and preparation of the Supplemental Environmental Assessment (SEA) for DDT to be used in the 2007-2008 IRS campaign jointly with the MoH;
☛ Work with the DPS to prepare and finalize an operational plan for IRS campaign in Zambezia Province;
☛ Procure spray cans and spare parts, personal protective equipment, and other necessary supplies for the spray campaign.
☛ Provide financial and technical support for the training of Spray teams (supervisors, team leaders, coordinators, spray operators) and Community Mobilizers
☛Provide financial and technical support for IEC campaigns through mass media
☛Initiate and support the collaboration of other partners in agriculture and environment during the training of the spray teams

During campaign:

☛ Provide managerial, supervisory and technical assistance for the IRS operations in 6 districts of Zambezia Province, namely Quelimane, Nicoadala, Namacurra, Mocuba, Morrumbala and Milange.
☛ Provide logistical support (transportation, fuel, working materials, Protective clothing etc) to the spray teams and community Mobilizers (including mass media, production of educational materials); and preposition the materials for the campaign
☛ Pay the arrears accumulated by the DPS for the rental of storage facilities in the 3 districts with no DPS storage capacity through till the end of the spray campaign. Arrears will not be paid in Quelimane.
☛ Provide storage space for the DPS in Quelimane.
☛ Provide supportive supervision and direction for the mobilization and spraying to ensure coverage in all targeted areas ;
☛Support DPS in data collection, collation and interpretation
☛ Discuss areas/functions in which additional technical assistance is needed as identified by the DPS;
☛ Support the initiation of an IRS working group in Zambezia province that incorporates other ministries that the IRS programme has a direct effect on (Ministry of Agriculture, Environment etc).
☛ Discontinue payment of storage fees once the spray campaign comes to a close and will recover all materials back to Quelimane at the end of the campaign.

Post campaign:

☛ Conduct post-IRS Campaign evaluation, including a review of records on insecticide used and results from bioassays, effectiveness of community mobilization and radio spots, to identify successes and gaps and come up with recommendations;

☛ Collaborate with the DPS in reporting on spraying activities and results as required by USAID.

☛ Provide additional technical assistance based on needs identified during the campaign in preparedness for the next round of spraying operations.

☛ Train entomology technicians and support the cost of establishing an entomology laboratory.

☛ Provide per diem and transport cost for the field entomology work.

The Provincial Department of Health (DPS) agrees to:

Pre-Campaign:

☛ Provide official notice to the National Environment Office of the planned IRS activities including information on the area where IRS will take place, insecticide to be used, application practices, the education of workers and beneficiaries, and the USAID SEA requirements;

☛ Provide official notice of RTI's involvement in the 2007/08 IRS campaign and provide an introduction of RTI teams to DPS, MICOA representatives;

☛ Provide RTI with data and clinical reports of malaria and any other epidemiological data that reflects malaria related information;

☛ Conduct an initial work planning meeting in collaboration with RTI International and its partners to finalize a work plan for IRS activities and technical support based on identified needs;

☛ Work in partnership with RTI in initiating an IRS working group to include MINAG, MICOA and others, to be formed in time to participate in the evaluation process;

☛ With assistance from RTI, train storekeepers and drivers in accordance with the guidance provided in this Supplemental Environmental Assessment (SEA) and the Food and Agricultural Organization's (FAO's) Pesticide Storage and Stock Control Manual;

☛ Train health workers in insecticide poisoning treatment, and ensure treatment medicines for insecticide exposure are available in districts targeted for IRS;

☛ Work with RTI in the training of spray operators, team leaders and supervisors according to best practices, as outlined by the SEA attachment A, particularly integrating training on recognition of pesticide poisoning symptoms, advised actions when symptoms occur, and referral options;

☛ Work with the Ministry of Health to ensure that quantities of DDT and other supplies necessary for spray operation in Zambezia Province are present in Central warehouse before the beginning of the spray season;

☛Ensure the spraying personnel and communities are aware that DDT is to be used for malaria control only and not for other activities

☛ Collaborate with RTI to educate target communities through an Information, Education and Communication (IEC) campaign, citing importance of removing all food, water 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;

☛ Inform fire brigades of the location and contents of storage facilities;

☛Mobilize the communities for the selection of Spray operators and Community Mobilizers;

☛ Carry out interviewing, selection and employment of the community Mobilizers and Spray operators;

☛ Ensure that pregnant or lactating women are not included in the spraying activity and that they understand the reasons;

☛ Identify an appropriate training site for the spray operators and community Mobilizers;

☛ Hire and support the salaries of entomology technicians to be trained.

<u>During the campaign:</u>

☛ Ensure the spray operators follow the guidelines on IRS through reinforcing the prohibition of spraying rooms where sick or pregnant persons live and cannot be moved out of the house during spraying and for one hour post-spraying;

☛ Reduce environmental contamination through continuous reminders to the spray operators on strict auditing of insecticide sachets, supervision of pesticide use, and avoiding contamination of the environment with insecticide by practicing good operator hygiene, rinsing and maintenance of sprayers, and washing of Personal Protective Equipment (PPE) in accordance with WHO guidelines;

☛ Reduce household materials and furniture exposure to DDT by covering furniture that cannot be moved from the houses prior to spraying.

☛ Ensure data collected is accurate and depicts the actual status of the field operations;

☛ supervise the spray operators and mobilization teams and work with RTI to mitigate malpractices;

☛Follow up and ensure that quality spraying is done within the expected time plan

☛ Ensure that there is tight control and monitoring of DDT flow from the warehouses to the spray sites;

☛ Investigate as a matter of urgency, any reports of DDT powder or sachets either found in houses or markets;

☛ With RTI support, appoint an independent multi-sectoral operations monitoring team;

☛ Collaborate with MICOA and Agricultural departments on identified malpractices and good practices and make recommendations;

<u>Post-Campaign:</u>

☛ With assistance from RTI, conduct post-IRS Campaign evaluation, including records on insecticide used and results from bioassays.

☛ Generate a report and share with other collaborating partners, USAID;

☛ Provide data on malaria incidence based on records of laboratory confirmed malaria;

☛ Document the IRS campaign and use lessons learned for planning future campaigns.

This Memorandum of Understanding will expire on June 30, 2008.

The MOU is made in *(Quelimane)* on _____

For the Provincial Department of Health	**For RTI International**
_____	_____
*Name*_____	*Name:* _____
*Title:*_____	*Title:* _____
Date: _____	*Date:*_____

Annex 2: Terms of Reference for Technical Committee on the Indoor Residual Spraying (IRS) Zanzibar

The committee is required to perform the following tasks:

1. Advise and report to the Minister of Health and Social Welfare and also to the Executive committee of the Ministry of health in all issues concerning IRS
2. The Technical committee will work together with the Ministry of Health and Social Welfare particularly with staff from the Zanzibar Malaria Control Programme.
3. Budgeting the IRS activities based to the PMI approval budget
4. Develop and translate the IRS protocol to the District supervisors and spraying team, which will guide IRS implementation in Unguja and Pemba. The protocol to be jointly discussed and agreed upon between the IRS consultant and Malaria Control Program and Technical committee.
5. Identify and approve training need of spraying man.
6. Selecting and leading the sprayer man in conducting the IRS exercises and provide technical guidance required
7. Prepared periodically progress report of the IRS activities
8. Mobilize resources required for IRS operation from deferent Government and Non Government sectors

Proposed Working Groups

Some changes were made to the proposed working groups based on the practical experiences and gaps observed during the discussion.

1. Executive Committee will be presented by the following members

Members:

- Principal Secretary(MoHSW)
- P/S –Agriculture
- Director Environment
- P/S – Regional Adminstration
- Director Chief Minister's Office
- Chairperson of IRS Technical Committee(Directors)

- Secretary of IRS Technical Committee (Programme Manager ZMCP)
- RTI Advisor ZMCP
- Vector Control Focal Person ZMCP

Task:

- Oversee activities of other committees
- Ensure timely availability of financial and other operational resources for IRS timely
- Decide on matters of urgency pending a meeting of Technical Committee.
- Collaborate with consultants, international and local organizations pertaining to IRS issues.

2. IEC/Community Mobilization Committee

Members:

- Health Education Unit MoHSW
- IEC focal Person ZMCP
- Ministry of Information
- NGO Representative
- T- MARK
- Vector Control Officer MoHSW
- Region Administration Representative
- Sociologist
- RTI Advisor

Task:

- Development of IEC material/messages
- Pre-testing IEC materials/messages
- Production of IEC materials
- Dissemination of IEC material
- Conduct Health education campaigns on IRS

3. Logistic and Supply Committee

Members:

- M/Communication and Transport
- Ministry of Finance Representative
- Medical store Department MoHSW
- Transport Officer MoHSW
- IRS Advisor ZMCP

Task:

- Facilitate tax exemption of goods for IRS
- Procurement of IRS equipment
- Storage and distribution of all supplies to respective areas of operation
- Allocate transport and other supplies according to IRS plan

4. Environmental Monitoring Committee

Members:

- Environmental Department
- Environmental Health Unit MoHSW
- Water Department
- Marine Science Institution
- Ministry of Agriculture
- Vector Control Officer MoHSW
- Medical Doctors MoHSW

Task:

- Manage safety disposal of used pesticide sachets
- Monitoring blood picture changes, congenital malformation, incidence of cancers etc.
- Monitoring of Environmental pollution
- Regular follow-up of warehouses

5. Training and IRS Operation Committee

Members:

- Vector Control/ Entomologist - MoHSW
- Regional Gov. Administration
- Local Sprayer maintenance
- RTI Advisor

Task:

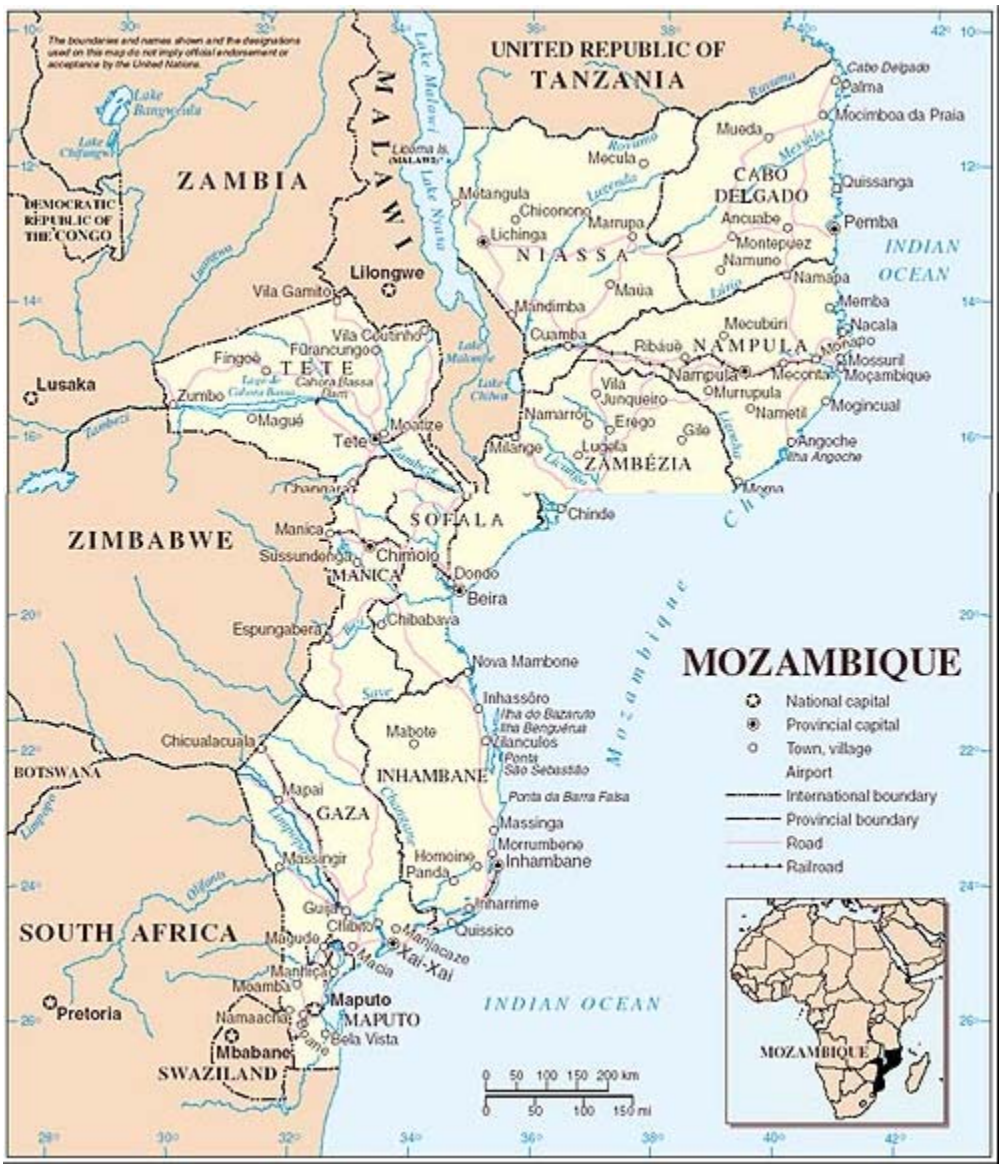
- Selection of supervisors and Operators
- TOT for supervisors
- Spray operators training
- Geographical reconnaissance
- District level micro planning
- Oversee entomological monitoring
- Medical Doctors

- Nurses
- Pharmacist
- Ensure timely availability of financial and other operational resources for IRS

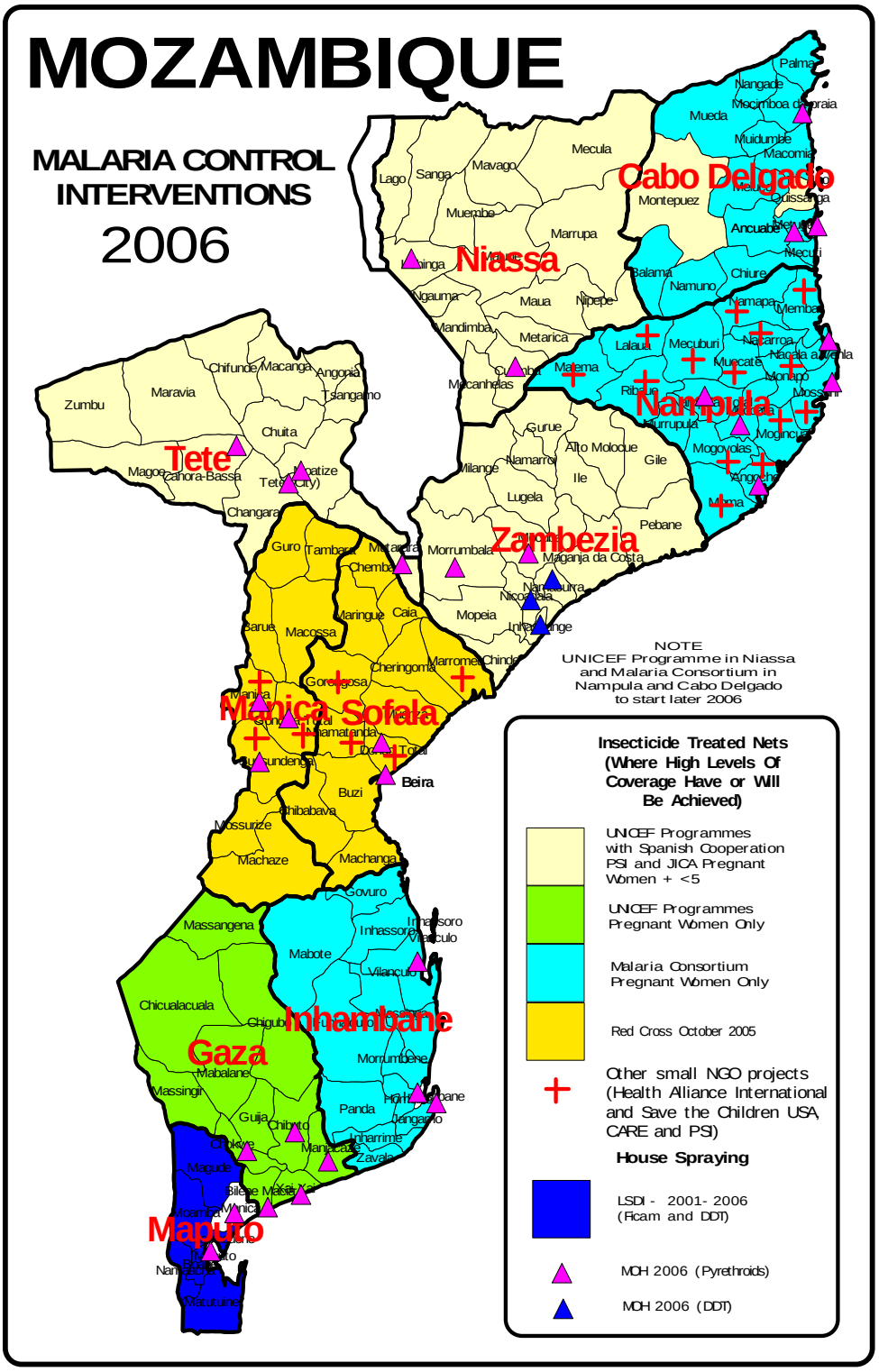
6. First Aid Committee

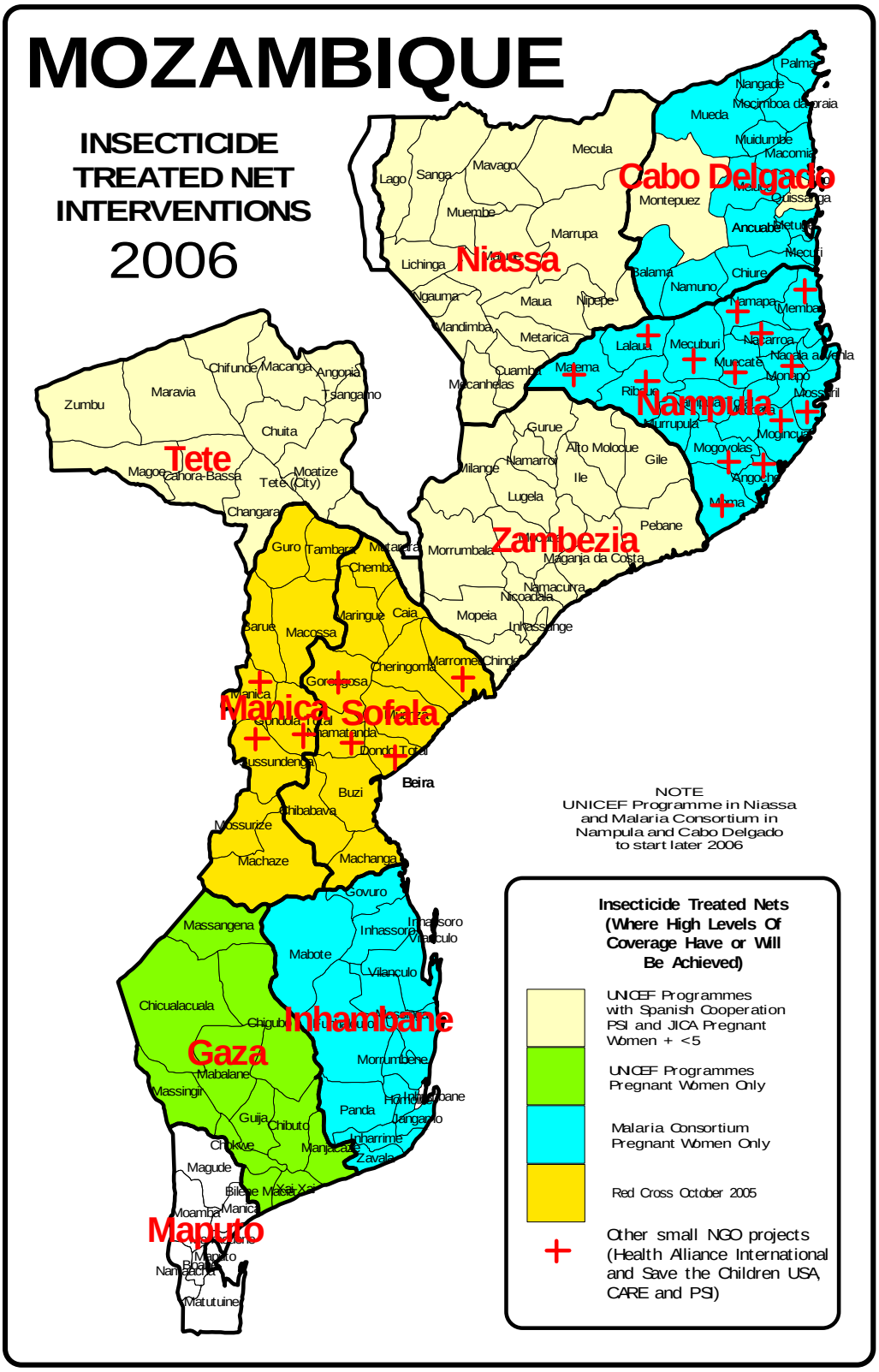
Training to local peripheral staff to be conducted by Medical Practitioners to equip them on pesticide reactions, toxicity and its overall management. First aid kits to be made available

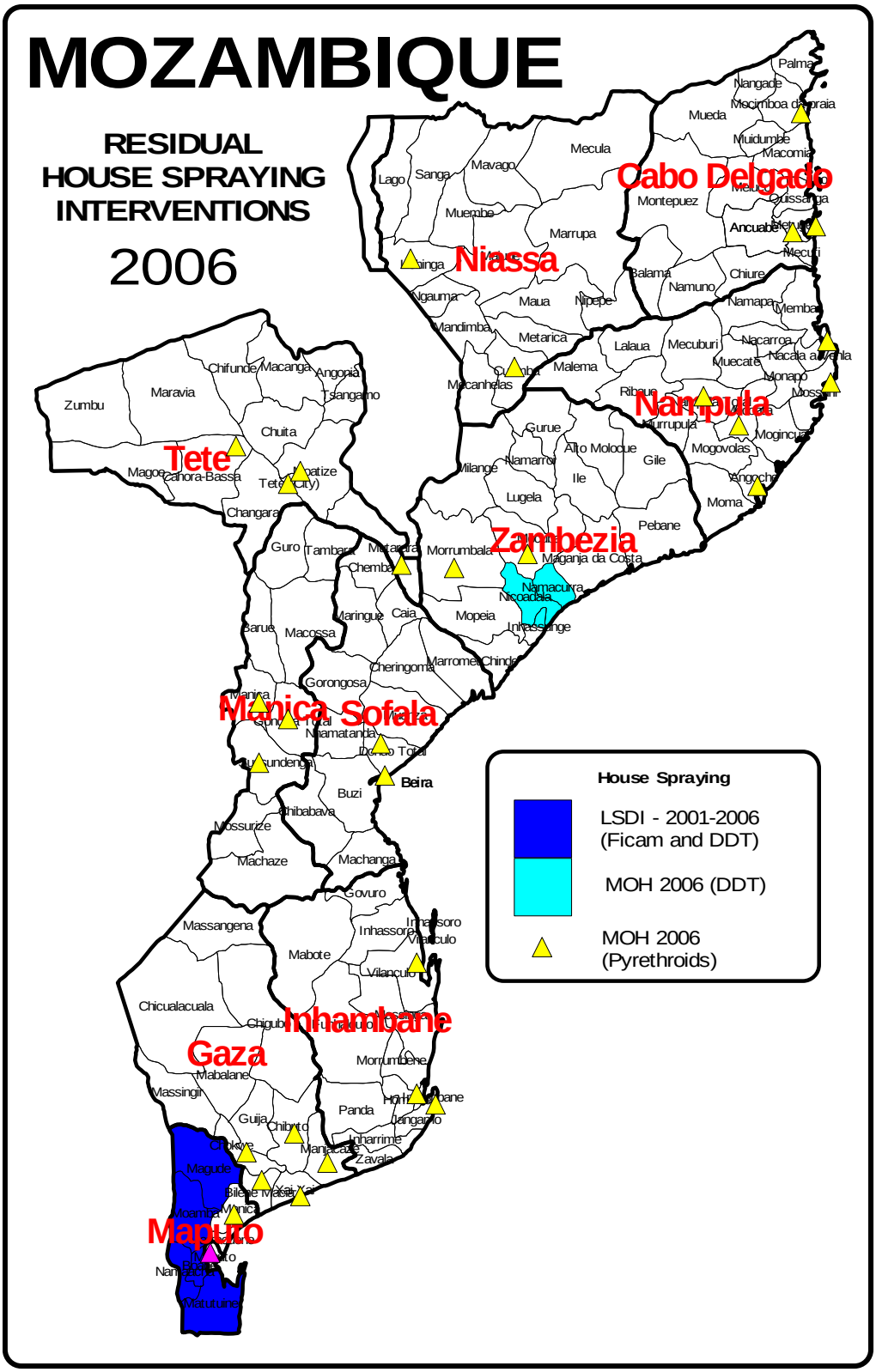
Annex 3: Map of Mozambique, UN

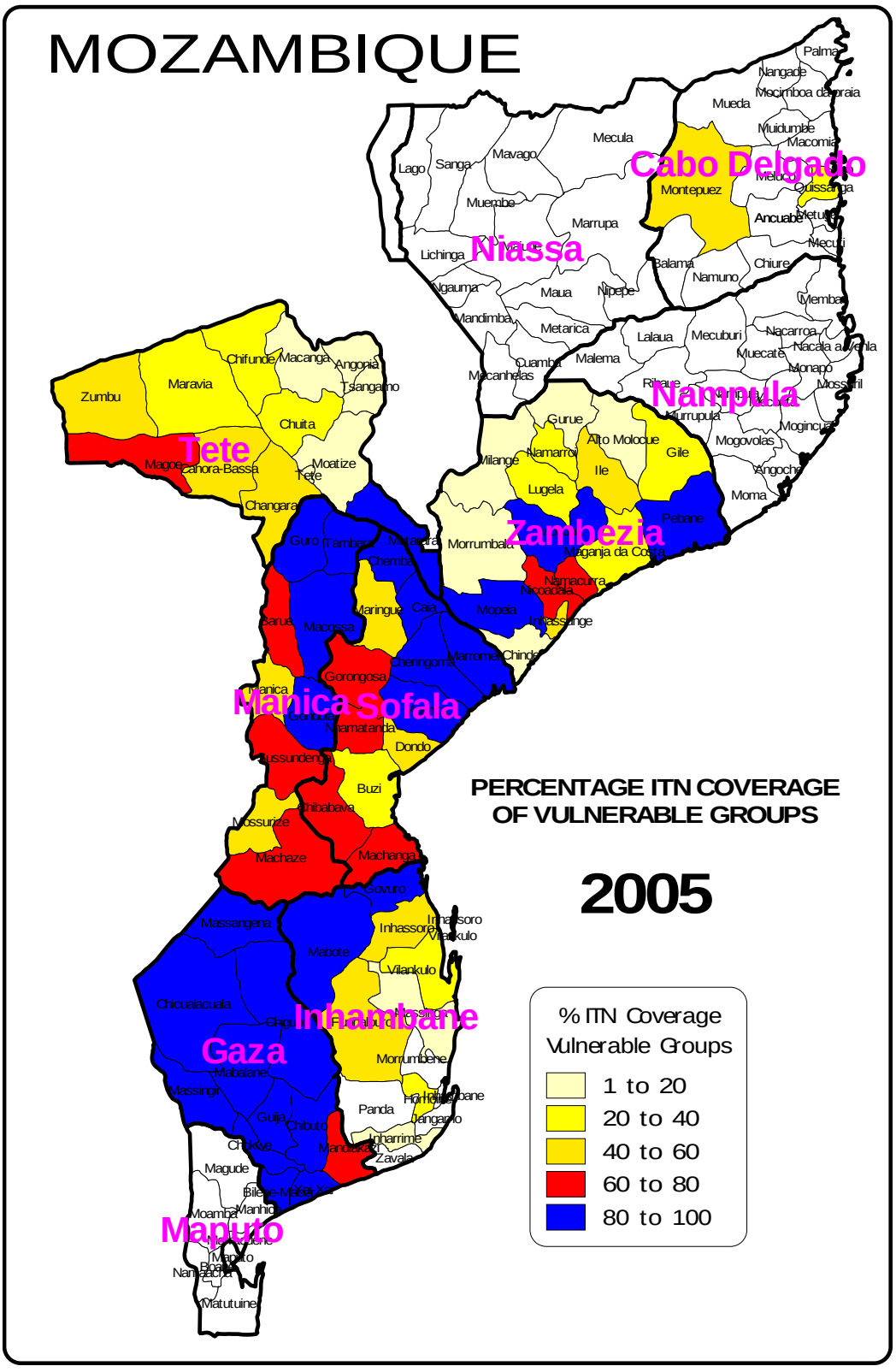


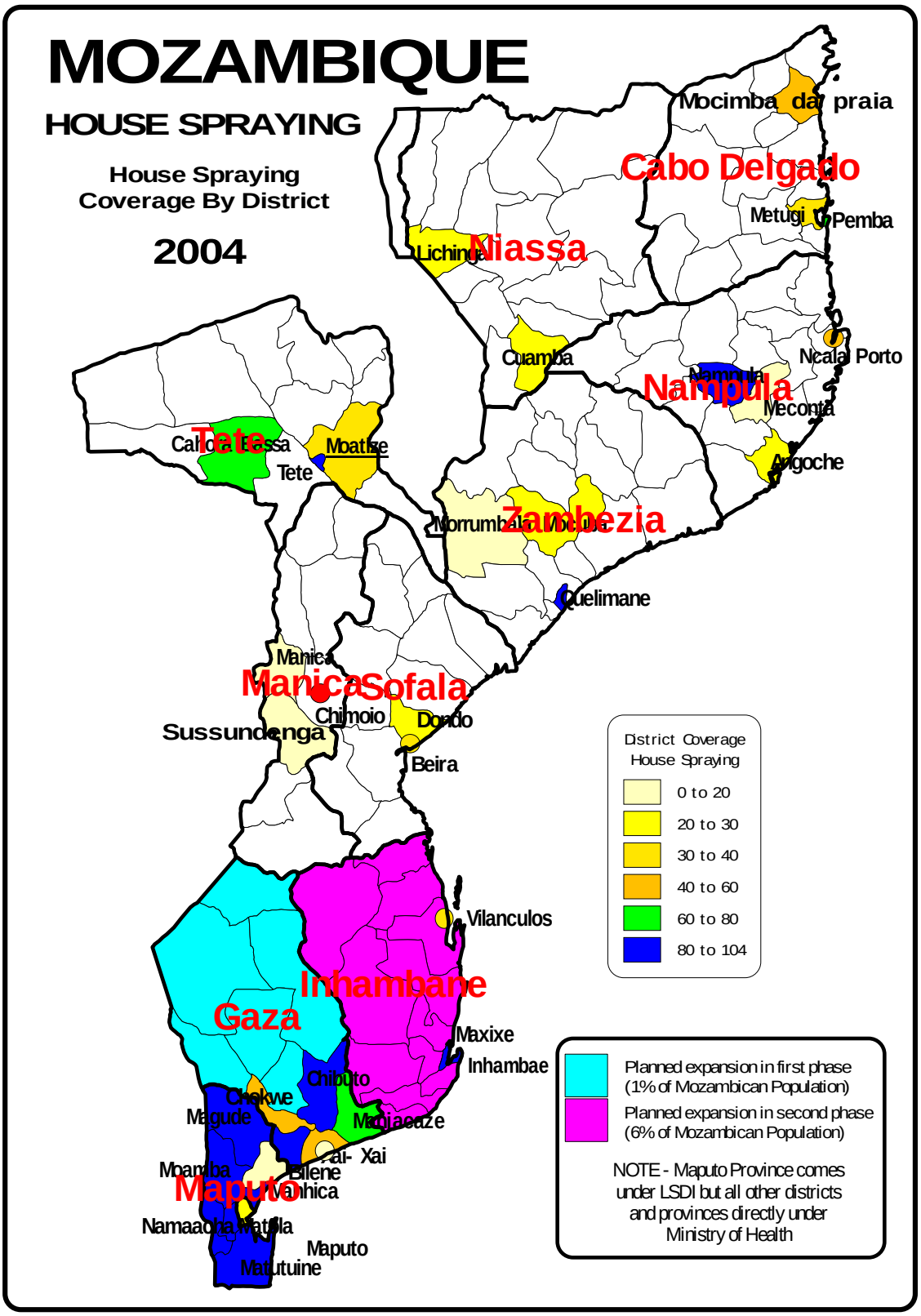
Annex 4: Malaria Control Intervention Maps, UNICEF


MOZAMBIQUE
MALARIA CONTROL INTERVENTIONS
2006
Niassa
Cabo Delgado
Nampula
Zambezia
Tete
Manica
Sofala
Inhambane
Gaza
Maputo
Beira
NOTE
UNICEF Programme in Niassa and Malaria Consortium in Nampula and Cabo Delgado to start later 2006
Insecticide Treated Nets (Where High Levels Of Coverage Have or Will Be Achieved)
UNICEF Programmes with Spanish Cooperation PSI and JICA Pregnant Women + <5
UNICEF Programmes Pregnant Women Only
Malaria Consortium Pregnant Women Only
Red Cross October 2005
Other small NGO projects (Health Alliance International and Save the Children USA, CARE and PSI)
House Spraying
LSDI - 2001- 2006 (Ficam and DDT)
MOH 2006 (Pyrethroids)
MOH 2006 (DDT)


MOZAMBIQUE
INSECTICIDE TREATED NET INTERVENTIONS
2006
Cabo Delgado
Niassa
Nampula
Zambezia
Tete
Manica
Sofala
Inhambane
Gaza
Maputo
Beira
NOTE
UNICEF Programme in Niassa and Malaria Consortium in Nampula and Cabo Delgado to start later 2006
Insecticide Treated Nets (Where High Levels Of Coverage Have or Will Be Achieved)
UNICEF Programmes with Spanish Cooperation PSI and JICA Pregnant Women + <5
UNICEF Programmes Pregnant Women Only
Malaria Consortium Pregnant Women Only
Red Cross October 2005
Other small NGO projects (Health Alliance International and Save the Children USA, CARE and PSI)


MOZAMBIQUE
RESIDUAL
HOUSE SPRAYING
INTERVENTIONS
2006
Cabo Delgado
Niassa
Nampula
Tete
Zambezia
Manica
Sofala
Inhambane
Gaza
Maputo
Palma
Nangade
Mueda
Mecula
Lago
Sanga
Mavago
Montepuez
Ancuabe
Marrupa
Balama
Chiure
Namuno
Ngauma
Maua
Nipepe
Namapa
Mandimba
Metarica
Lalaua
Mecuburi
Nacarroa
Muecate
Malema
Mecanhelas
Ribaue
Gurue
Murrupula
Mogincual
Alto Molocue
Mogovolas
Gile
Milange
Namarroi
Ile
Lugela
Pebane
Zumbu
Maravia
Chifunde
Macanga
Angonia
Tsangano
Chuita
Magoe
Zahora-Bassa
Changara
Guro
Tambara
Chemba
Morrumbala
Maganja da Costa
Namacurra
Nicoadala
Mopeia
Inhassunge
Maringue
Caia
Barue
Macossa
Cheringoma
Marromeu
Chinde
Gorongosa
Manica
Gondola
Nhamatanda
Dondo
Beira
Buzi
Chibabava
Mossurize
Machaze
Machanga
Govuro
Massangena
Inhassoro
Vilanculo
Mabote
Chicualacuala
Chigubo
Funhalouro
Mabalane
Massingir
Morrumbene
Panda
Inharrime
Zavala
Guija
Chibuto
Manjacaze
Chokwe
Magude
Moamba
Matutuine
House Spraying
LSDI - 2001-2006
(Ficam and DDT)
MOH 2006 (DDT)
MOH 2006
(Pyrethroids)


MOZAMBIQUE
Cabo Delgado
Niassa
Nampula
Tete
Zambezia
Manica
Sofala
Inhambane
Gaza
Maputo
PERCENTAGE ITN COVERAGE OF VULNERABLE GROUPS
2005
% ITN Coverage Vulnerable Groups
1 to 20
20 to 40
40 to 60
60 to 80
80 to 100


MOZAMBIQUE
HOUSE SPRAYING
House Spraying
Coverage By District
2004
Mocimba da praia
Cabo Delgado
Metugi
Pemba
Lichinga
Niassa
Cuamba
Ncala Porto
Nampula
Nampula
Meconta
Angoche
Tete
Cahora Bassa
Moatize
Tete
Zambezia
Morrumbala
Mocuba
Quelimane
Manica
Manica
Sofala
Chimoio
Dondo
Sussundenga
Beira
Vilanculos
Inhambane
Gaza
Maxixe
Inhambae
Chibuto
Chokwe
Magude
Manjacaze
Xai- Xai
Moamba
Bilene
Maputo
Namaacha
Matola
Maputo
Matutuine
District Coverage
House Spraying
0 to 20
20 to 30
30 to 40
40 to 60
60 to 80
80 to 104
Planned expansion in first phase
(1% of Mozambican Population)
Planned expansion in second phase
(6% of Mozambican Population)
NOTE - Maputo Province comes
under LSDI but all other districts
and provinces directly under
Ministry of Health

Annex 5: Exposure Treatment Guidelines*

Section 1: Specific Treatment Guidelines for WHO-Recommended Insecticides for Indoor Residual Spraying (IRS) for Malaria

Organochlorines

DDT is the only insecticide of the organochlorine chemical group that is still recommended for indoor residual spraying (IRS). Previously used organochlorines belonged to the cyclodiene sub-class, which included dieldrin and HCH. Dieldrin was abandoned because of its high acute toxicity to humans. Eventually, the whole subgroup became unusable because a mechanism common to all cyclodienes caused the rapid development of resistance.

DDT

DDT is an organochlorine insecticide with low volatility and very low solubility in water, but which is soluble in fats and organic solvents. DDT is highly persistent and has a long residual effect on most sprayed surfaces. The long persistence in the environment and its high bioaccumulation in fatty tissues have contributed to the dispersal of DDT residues everywhere (including arctic ice) from the agricultural use of DDT in the 1950s and 1960s. This bioaccumulation has resulted in highly toxic effects at the top of food chains, particularly in sharks, eagles, and falcons.

The main danger of environmental contamination from using DDT as an indoor residual spray comes from diverting the insecticide from malaria control to agricultural use. A similar danger would occur if containers were inadequately disposed of or pumps indiscriminately washed in surface waters. These risks could be prevented by proper education and strict supervision.

Toxicology

Absorption route: Absorbed from the gastrointestinal tract and by inhalation. DDT in oily solution may also be absorbed through intact skin. This is not applicable to the WP formulations used for malaria control.

Mode of action: DDT is a central nervous system stimulant that produces hyperactivity and tremor; convulsions may occur but are less common than with other organochlorine insecticides.

* US Agency for International Development. Draft 4. Integrated Vector Management Programs for Malaria Vector Control: Programmatic Environmental Assessment. March 2006. Prepared by RTI International. Contract GHS-I-01-03-00028-000-1. Prepared for Bureau for Global Health, USAID.

Symptoms of poisoning

Acute poisoning by DDT is very rare, particularly when used for indoor residual spraying. Nevertheless, it could potentially occur if there is gross mishandling. Early symptoms may include paresthesia (tingling) of the tongue, lips, and parts of the face, which in severe cases extends to the extremities. The patient may have a sense of apprehension and disturbance of equilibrium, dizziness, confusion, and a characteristic tremor.

Emergency Treatment

Emergency treatment for organochlorine pesticide exposure includes removing the contaminated clothing, washing the affected skin with clean water and soap, and flushing the affected area with large quantities of clean water. Keep the patient calm and in quiet, shaded conditions and seek medical assistance. Do not give the patient oils and fats.

Treatment by Medical Professional

1. **Observation**. Persons exposed to high levels of organochlorine pesticides by any route should be observed for sensory disturbances, incoordination, speech slurring, mental aberrations, and involuntary motor activity that would warn of imminent convulsions.

Convulsions. If convulsions occur, place the victim in the left lateral decubitus position with the head down. Move away furniture or other solid objects that could be a source of injury. If jaw movements are violent, place padded tongue blades between the teeth to protect the tongue. Whenever possible, remove dentures and other removable dental work. Aspirate oral and pharyngeal secretion, and when possible, insert an oropharyngeal airway to maintain an open passage unobstructed by the tongue. Minimize noise and any manipulation of the patient that may trigger seizure activity.

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.**

Although lorazepam is widely accepted as a treatment of choice for status epilepticus, there are no reports of its use for organochlorine intoxication. Some cases have required aggressive management that included the addition of phenobarbital and induction of entobarbital coma.

Seizures in patients caused by organochlorine toxicity are likely to be prolonged and difficult to control. Status epilepticus is common. For this reason, patients with seizures that do not respond immediately to anticonvulsants should be transferred as soon as possible to a trauma center and will generally require intensive care admission until seizures are controlled and neurologic status is improved. Initial therapy with benzodiazepines should be instituted.

Oxygen. Administer oxygen by mask. Maintain pulmonary gas exchange by mechanically assisted ventilation whenever respiration is depressed.

Skin decontamination. Thoroughly decontaminate the skin.

Gastrointestinal decontamination. If organochlorine has been ingested in a quantity sufficient to cause poisoning and the patient presents symptoms within an hour, consider gastric decontamination procedures. If the patient presents more than an hour after ingestion, activated charcoal may still be beneficial. If the victim is convulsing, it is almost always necessary first to control the seizures before attempting gastric decontamination. Activated charcoal administration has been advocated in such poisonings, but there is little human or experimental evidence to support it.

Respiratory failure. Particularly in poisonings by large doses of organochlorine, monitor pulmonary ventilation carefully to forestall respiratory failure. Assist pulmonary ventilation mechanically with oxygen whenever respiration is depressed. Because these compounds are often formulated in a hydrocarbon vehicle, hydrocarbon aspiration may occur with ingestion of these agents. The hydrocarbon aspiration should be managed in accordance with accepted medical practice as a case of acute respiratory distress syndrome, which will usually require intensive care management.

Cardiac monitoring. In severely poisoned patients, monitor cardiac status by continuous ECG recording to detect arrhythmia.

Contraindications. Do not give epinephrine, other adrenergic amines, or atropine unless absolutely necessary because of the enhanced myocardial irritability induced by chlorinated hydrocarbons, which predisposes to ventricular fibrillation. Do not give animal or vegetable oils or fats by mouth. They enhance gastrointestinal absorption of the lipophilic organochlorines.

Phenobarbital. To control seizures and myoclonic movements that sometimes persist for several days following acute poisoning by the more slowly excreted organochlorines, phenobarbital given orally is likely to be effective. Dosage should be based on manifestations in the individual case and on information contained in the package insert.

Cholestryamine resin. Cholestryamine resin accelerates the biliary-fecal excretion of the more slowly eliminated organochlorine compounds. It is usually administered in 4 g doses, 4 times a day, before meals and at bedtime. The usual dose for children is 240 mg/kg/24 hours, divided Q 8 hours. The dose may be mixed with a pulpy fruit or liquid. It should never be given in its dry form and must always be administered with water, other liquids, or a pulpy fruit. Prolonged treatment (several weeks or months) may be necessary.

Convalescence. During convalescence, enhance carbohydrate, protein, and vitamin intake by diet or parenteral therapy.

Carbamates

Carbamates are fast-acting anticholinesterase (AchE) compounds, with relatively high acute oral toxicity.

Toxicology

The inhibition of AchE induced by carbamates is relatively labile. As a result, although symptoms may occur during operational exposure, the patient recovers normally follows once exposure stops. Specific toxicology information on the approved carbamates is as follows:

Bendiocarb

Bendiocarb is a carbamate insecticide with low vapor pressure, low odor and no corrosive and staining properties. This makes it acceptable to most householders. It is rapidly hydrolysed in alkaline media (such as whitewash) and rapidly degraded in soil. Like other N-methylcarbamates, bendiocarb is a fast-acting anticholinesterase compound, with high acute oral toxicity.

Toxicology

Bendiocarb may be absorbed from the gastrointestinal tract or, to a limited extent, through intact skin. It is mainly metabolized through hydrolysis and excreted rapidly; there is no accumulation in organs and tissues. Its low vapor pressure makes inhalation unlikely except from airborne spray mist.

Mode of action: Bendiocarb inhibits cholinesterase activity, which is rapidly reversible. The half-life of the inhibited enzyme is approximately 30 minutes.

Symptoms of poisoning

Symptoms of mild carbamate poisoning are similar to those of organophosphate poisoning. They include 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. These symptoms rapidly subside when spraying is stopped and heavily contaminated clothes are removed, particularly if some atropine is given to the patient.

Propoxur

Toxicology

Absorption route: Propoxur can be absorbed by inhalation, from the gastrointestinal tract and, to a lesser extent, through intact skin. The compound is rapidly metabolized and does not accumulate in tissues.

Mode of action: Inhibition of cholinesterase, which is relatively rapidly reversible.

Symptoms of poisoning

Symptoms of mild carbamate poisoning are similar to those of organophosphate poisoning. They include 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. These symptoms rapidly subside when spraying is stopped and heavily contaminated clothes are removed, particularly if some atropine is given to the patient.

Emergency Treatment

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 (show medical personnel the product label).

The patient can be treated by atropine, but it is often no longer necessary by the time the patient reaches the place where atropine is available. Oximes are contraindicated for the treatment of carbamate poisoning. Morphine should not be used, but diazepam may be useful for convulsions.

Treatment by Medical Professional

Caution: Persons attending the victim should avoid direct contact with heavily contaminated clothing and vomitus. Wear rubber gloves while washing pesticide from skin and hair. Vinyl gloves provide no protection.

1. **Airway protection**. Ensure that a clear airway exists. Intubate the patient and aspirate the secretions with a large-bore suction device if necessary. Administer oxygen by mechanically assisted pulmonary ventilation if respiration is depressed. Improve tissue oxygenation as much as possible before administering atropine to minimize the risk of ventricular fibrillation. In severe poisonings, it may be necessary to support pulmonary ventilation mechanically for several days.

2. **Atropine**. Administer atropine sulfate intravenously or intramuscularly if intravenous injection is not possible. Remember that atropine can be administered through an endotracheal tube if initial IV access is difficult to obtain. Carbamates usually reverse with much smaller dosages of atropine than those required to reverse organophosphates. (See dosage on next page.)

The objective of atropine antidotal therapy is to antagonize the effects of excessive concentrations of acetylcholine at end-organs having muscarinic receptors. Atropine does not reactivate the cholinesterase enzyme or accelerate excretion or breakdown of carbamate. Recrudescence of poisoning may occur if tissue concentrations of toxicant remain high when the effect of atropine wears off. Atropine is effective against muscarinic manifestations, but is ineffective against nicotinic actions, specifically, muscle weakness and twitching, and respiratory depression.

Despite these limitations, atropine is often a life-saving agent in N-methyl carbamate poisonings. Favorable response to a test dose of atropine (1 mg in adults, 0.01 mg/kg in children under 12 years) given intravenously can help differentiate poisoning by anticholinesterase agents from other conditions such as cardiogenic pulmonary edema and hydrocarbon ingestion. However, lack of response to the test dose, indicating no atropinization (atropine refractoriness), is characteristic of moderately severe to severe poisoning and indicates a need for further atropine. If the test dose does not result in mydriasis and drying of secretions, the patient can be considered atropine refractory.

Dosage of Atropine:

In *moderately severe poisoning* **(hypersecretion and other end-organ manifestations without central nervous system depression), the following dosage schedules have proven effective:**

- ***Adults and children over 12 years:*** **2.0-4.0 mg, repeated every 15 minutes until pulmonary secretions are controlled, which may be accompanied by other signs of atropinization, including flushing, dry mouth, dilated pupils, and tachycardia (pulse of 140 per minute).** Warning: **In cases of ingestion of liquid concentrates of carbamate pesticides, hydrocarbon aspiration may complicate these poisonings. Pulmonary edema and poor oxygenation in these cases will not respond to atropine and should be treated as a case of acute respiratory distress syndrome.**
- ***Children under 12 years:*** **0.05-0.1 mg/kg body weight, repeated every 15 minutes until pulmonary secretions are controlled, which may be accompanied by other signs of atropinization as above (heart rates vary depending on age of child with young toddlers having a rate approaching 200). There is a minimum dose of 0.1 mg in children.**

Maintain atropinization by repeated doses based on recurrence of symptoms for 2-12 hours or longer depending on severity of poisoning. Crackles in the lung bases nearly always indicate inadequate atropinization and pulmonary improvement may not parallel other signs. Continuation or return of cholinergic signs indicates the need for more atropine.

Severely poisoned **individuals may exhibit remarkable tolerance to atropine; two or more times the dosages suggested above may be needed. Reversal of muscarinic manifestations, rather than a specific dosage, is the object of atropine therapy. However, prolonged intensive intravenous administration of atropine sometimes required in organophosphate poisonings is rarely needed in treating carbamate poisoning.**

Note: Persons not poisoned or only slightly poisoned by N-methyl carbamates may develop signs of atropine toxicity from such large doses. Fever, muscle fibrillations, and delirium are the main signs of atropine toxicity. If these signs appear while the patient is fully atropinized, atropine administration should be discontinued, at least temporarily, while the severity of poisoning is reevaluated.

3. **Skin decontamination**. In patients with contaminated skin, clothing, hair, and/or eyes, decontamination must proceed concurrently with whatever resuscitative and antidotal measures are needed to preserve life. Flush the chemical from eyes with copious amounts of clean water. For asymptomatic individuals who are alert and physically able, a prompt shower and shampoo may be appropriate for thorough skin decontamination, provided the patient is carefully observed to insure against sudden appearance of poisoning. 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. Wash the chemical from skin folds and from under fingernails. Attendants should wear rubber gloves, as vinyl provides no protection against skin absorption.

Contaminated clothing should be promptly removed, bagged, and laundered before returning. Contaminated leather shoes should be discarded. Note that the pesticide can contaminate the inside surfaces of gloves, boots, and headgear.

4. **Gastrointestinal decontamination**. If N-methyl carbamate has been ingested in a quantity probably sufficient to cause poisoning, consider giving gastrointestinal decontamination as outlined in Chapter 2. If the patient has presented with a recent ingestion and is still asymptomatic, adsorption of poison with activated charcoal may be beneficial. In significant ingestions, diarrhea and/or vomiting are so constant that charcoal adsorption and catharsis are not indicated. Attention should be given to oxygen, airway management, and atropine.

5. **Urine sample**. Save a urine sample for metabolite analysis if there is need to identify the agent responsible for the poisoning.

6. **Pralidoxime** is probably of little value in N-methyl carbamate poisonings because atropine alone is effective. Although not indicated in isolated carbamate poisoning, pralidoxime appears to be useful in cases of mixed carbamate/organophosphate poisonings and cases of an unknown pesticide that present with muscarinic symptoms.

7. **Observation**. Observe patient closely for at least 24 hours to ensure that symptoms (sweating, visual disturbances, vomiting, diarrhea, chest and abdominal distress, and sometimes pulmonary edema) do not recur as atropinization is withdrawn. The observation period should be longer in the case of mixed pesticide ingestion, because of the prolonged and delayed symptoms associated with organophosphate poisoning. As the dosage of atropine is reduced over time, check the lung bases frequently for crackles. Atropinization must be re-established promptly, if crackles are heard, or if there is a return of miosis, sweating, or other signs of poisoning.

8. **Furosemide** may be considered for relief of pulmonary edema if crackles persist in the lungs even after full atropinization. Furosemide should not be considered until the maximum effect of atropine has been achieved. Consult package insert for dosage and administration.

9. **Pulmonary ventilation**. Particularly in poisonings by large doses of N-methyl carbamates, monitor pulmonary ventilation carefully to forestall respiratory failure, even after the patient recovers from muscarinic symptomatology.

10. **Cardiopulmonary monitoring**. In severely poisoned patients, monitor cardiac status by continuous ECG recording.

11. **Contraindications**. The following drugs are probably contraindicated in nearly all N-methyl carbamate poisoning cases: morphine, succinlycholine, theophylline, phenothiazines, and reserpine. Adrenergic amines should be given only if there is a specific indication, such as marked hypotension.

12. **Hydrocarbon** aspiration may complicate poisonings that involve ingestion of liquid concentrates of some carbamates formulated in a petroleum product base. Pulmonary edema and poor oxygenation in these cases will not respond to atropine and should be treated as cases of acute respiratory distress syndrome.

13. **Prophylaxis**. Do not administer atropine prophylactically to workers exposed to N-methyl carbamate pesticides. Prophylactic dosage may mask early symptoms and signs of carbamate poisoning and thus allow the worker to continue exposure and possibly progress to more severe poisoning. Atropine itself may increase the health hazards of the agricultural work setting, including impaired heat loss due to reduced sweating and impaired ability to operate mechanical equipment due to blurred vision (mydriasis).

Pyrethroids

These modern synthetic insecticides are similar chemically to natural pyrethrins, but modified to increase stability in the natural environment. They are now widely used in agriculture, in homes and gardens, and to treat ectoparasitic disease.

Pyrethroids are formulated as emulsifiable concentrates, wettable powders, granules, and concentrates for ultra low volume application. They may be combined with additional pesticides (sometimes highly toxic) in the technical product or tank-mixed with other pesticides at the time of application.

Toxicology

Certain pyrethroids exhibit striking neurotoxicity in laboratory animals when administered by intravenous injection, and some are toxic when ingested orally. However, systemic toxicity by inhalation and dermal absorption is low. Although limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible for this phenomenon. Most pyrethroid metabolites are promptly excreted (at least in part) by the kidney. Fatalities have occurred rarely after pyrethroid exposure, usually following ingestion (He et al., 1989).

The most severe toxicity is to the central nervous system, although more uncommon. Seizures have been reported in severe cases of pyrethroid intoxication. Seizures are more common with exposure to the more toxic cyano-pyrethroids, which include fenvalerate, flucythrinate, cypermethrin, deltapermethrin, and fluvalinate. There are no reports in the literature of seizures in humans from exposure to permethrin.

Apart from central nervous system toxicity, some pyrethroids do cause distressing paresthesia when liquid or volatilized materials contact human skin. Again, these symptoms are more common with exposure to the pyrethroids whose structures include cyano-groups. Sensations are described as stinging, burning, itching, and tingling, progressing to numbness. The skin of the face seems to be most commonly affected, but the hands, forearms, and neck are sometimes involved. Sweating, exposure to sun or heat, and applying water increase the disagreeable sensations. Sometimes the effect is noted within minutes of exposure, but a 1-2 hour delay in the appearance of symptoms is more common. Sensations rarely persist more than 24 hours. Little or no inflammatory reaction is apparent where the paresthesia is reported; the effect is presumed to result from pyrethroid contact with sensory nerve endings in the skin. The paraesthesia is not allergic

in nature, although sensitization and allergic responses have been reported as an independent phenomenon with pyrethroid exposure. Race, skin type, or disposition to allergic disease does not affect the likelihood or severity of the reaction.

Persons treated with permethrin for lice or flea infestations sometimes experience itching and burning at the site of application, but this is chiefly an exacerbation of sensations caused by the parasites themselves, and is not typical of the paraesthesia described above.

Other signs and symptoms of toxicity include abnormal facial sensations, dizziness, salivation, headache, fatigue, vomiting, diarrhea, and irritability to sound and touch. In more severe cases, pulmonary edema and muscle fasciculations can develop. Due to the inclusion of unique solvent ingredients, certain formulations of fluvalinate are corrosive to the eyes. Pyrethroids are not cholinesterase inhibitors. However, there have been some cases in which pyrethroid poisoning has been misdiagnosed as organophosphate poisoning, due to some of the similar presenting signs, and some patients have died from atropine toxicity.

Specific toxicology for the 5 recommended pyrethroids is described below.

Alpha-cypermethrin

Alpha-cypermethrin is a synthetic pyrethroid.

Toxicology

Absorption may occur to some extent after inhalation or dermal exposure but, as with other pyrethroids, alpha-cypermethrin is rapidly metabolized and excreted from the body.

Mode of action: Neurotoxicity through disruption of nerve fiber impulse transmission.

Cyfluthrin

Cyfluthrin is a synthetic pyrethroid with very low vapor pressure. It is readily hydrolyzesd under alkaline conditions, but quite stable at pH 7 or below. Cyfluthrin is very strongly adsorbed to organic matter and can be classified as immobile in soil.

Toxicology

The acute toxicity of cyfluthrin varies depending on the vehicle. Toxicity is high by ingestion but cyfluthrin has poor skin penetration. Although as other α-cyano-pyrethroids, it may irritate the eye and skin, 10 percent WP cyfluthrin is not irritating to the skin and only slightly irritating to mucous membranes.

Absorption route: After oral administration, about 90 percent was absorbed in the intestine. Absorption after inhalation is also possible. Dermal absorption is very low.

Mode of action: Cyfluthrin acts upon the peripheral nervous system as well as on regions of the central nervous system (e.g., certain binding sites—GABA-receptors—in the brain).

Deltamethrin

Deltamethrin is a synthetic pyrethroid of the alpha-cyano group. It is related to cypermethrin and lambda-cyhalothrin, and is a single isomer pyrethroid. Deltamethrin has been used in malaria control since the late 1970s, and has been impregnated in bednets or curtains and used for indoor residual spraying in spite of its marked excito-repellency, which in some situations may be an advantage as it reduces human-vector contact.

Deltamethrin is used at dosages of 10-25 mg/m^2 giving a residual effect of 3-6 months. Protective clothing for spraymen should consist of overalls (washed daily), canvas or rubber boots, and hats.

Toxicology

Deltamethrin is primarily absorbed from the gastrointestinal tract, but also by inhalation of spray mist.

Mode of action: A neurotoxin, acting primarily on the basal ganglia of the central nervous system, causing repetitive nerve action.

Etofenprox

Etofenprox is a synthetic non-ester pyrethroid with high vapor pressure and low water solubility. Etofenprox is the insecticide with lowest acute toxicity to mammals of those recommended for indoor residual spraying. It is used as a WP 20 percent formulation, at a dosage of 100-300 mg/m^2 giving a residual effect of 3-6 months.

Toxicology

Absorption route: Etofenprox may be absorbed from the gastrointestinal tract or through the intact skin.

Mode of action: Etofenprox disturbs nerve impulses in insect nerve axons.

Lambda-cyhalothrin

Lambda-cyhalothrin is a synthetic pyrethroid, of the alpha-cyano group, with a core (-CCOOCHCN-), as in alpha-cypermethrin and deltamethrin. Lambda-cyhalothrin has low vapor pressure, is essentially insoluble in water, and has low volatility. It is available in WP formulation and is used at a dosage of 20-30 mg/m^2 giving a residual effect of 3-6 months.

Toxicology

Absorption route: Lambda-cyhalothrin may be absorbed through the gastrointestinal tract, by inhalation, or through the skin. Skin absorption of lambda-cyhalothrin is very low and no systemic effects from skin absorption have been described. Dermal and inhalational exposures usually have mild or no adverse effects. Following substantial ingestion, patients may develop coma, convulsions, and severe muscle fasciculations, and may take

several days and occasionally weeks to recover. No known fatalities have been reported after lambda-cyhalothrin exposure.

Mode of action: Lambda-cyhalothrin's mode of action is the same as that of other alpha-cyano pyrethroids, primarily affecting the sodium channels in the nerve membrane and causing a long-lasting prolongation of the transient increase in sodium permeability of the membrane during excitation.

Symptoms of poisoning

In normal use, only local skin reactions have been reported. Any pyrethroid reaching the systemic circulation will be metabolized rapidly to much less toxic metabolites. The risk of toxicity of any kind to humans exposed by the usual routes is extremely remote, even with frequent exposure to the low concentrations used for malaria control. Systemic toxicity has not been seen in users, except on very rare occasions when few precautions were taken during packaging of pyrethroids and the victim's whole body was subjected to repeated and often prolonged exposure through soaked clothing.

Nevertheless, if ingested, these products may produce nausea, vomiting, cough, respiratory distress, and convulsions.

The field use of pyrethroids in the recommended concentrations, accompanied by the normal precautions for insecticide use, poses little or no hazard to applicators. Skin reactions such as pruritus, tautness and reddening of the facial skin, partial facial paraesthesia, and signs of irritation in the oropharyngeal cavity or coughing, especially when combined with increased sensitivity to touch stimuli, may be signs of dermal contact or inhalative exposure. These dermal sensations are direct and transitory effects on sensory nerve endings and are not the result of a primary skin irritation. Toxicologically, these are useful characteristics, as they provide an early indication of exposure.

After breathing in the insecticide spray mist, there may be irritation of respiratory mucous membranes with coughing and sneezing.

Treatment by Medical Professional

1. **Skin decontamination.** Wash skin promptly with soap and water. If irritant or paresthesia occurs, obtain treatment by a physician. Because volatilization of pyrethroids apparently accounts for paresthesia affecting the face, strenuous measures should be taken (ventilation, protective face mask and hood) to avoid vapor contact with the face and eyes. Vitamin E oil preparations (dL-alpha tocopheryl acetate) are uniquely effective in preventing and stopping the paresthesia. They are safe to apply to the skin under field conditions. Corn oil is somewhat effective, but possible side effects with continuing use make it less suitable. Vaseline is less effective than corn oil. Zinc oxide actually makes the reaction worse.

2. **Eye contamination.** Some pyrethroid compounds can be very corrosive to the eyes. Extraordinary measures should be taken to avoid eye contamination. The eye

should be treated immediately by prolonged flushing of the eye with copious amounts of clean water or saline. If irritation persists, obtain professional ophthalmologic care.

3. **Gastrointestinal decontamination.** If large amounts of pyrethroids, especially the cyano-pyrethroids, have been ingested and the patient is seen soon after exposure, consider gastrointestinal decontamination. Based on observations in laboratory animals and humans, large ingestions of allethrin, cismethrin, fluvalinate, fenvalerate, or deltamethrin would be the most likely to generate neurotoxic manifestations.

If only small amounts of pyrethroid have been ingested, or if treatment has been delayed, oral administration of activated charcoal and cathartic probably represents optimal management. Do not give cathartic if patient has diarrhea or an ileus.

4. **Other treatments.** Several drugs are effective in relieving the pyrethroid neurotoxic manifestations observed in deliberately poisoned laboratory animals, but none has been tested in human poisonings. Therefore, neither efficacy nor safety under these circumstances is known. Furthermore, moderate neurotoxic symptoms and signs are likely to resolve spontaneously if they do occur.

5. **Seizures.** Any seizures should be treated as outlined in the general principles for management of acute poisoning.

Section 2: General Principles in the Management of Acute Pesticide Poisonings

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 **organophosphate** 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.

1. **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.

2. **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 adsorbed beyond 60 minutes. Clinical trials with charcoal have been done with poisons other than pesticides. There is some evidence that paraquat is well adsorbed 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 organophosphates, 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 table 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 6: Endangered Species of Mozambique

Scientific Name	Common Name	Class	Population Trend
Dermochelys coriacea	LEATHERBACK, LEATHERY TURTLE, LUTH, TRUNKBACK TURTLE	CR	
Diceros bicornis	BLACK RHINOCEROS, HOOK-LIPPED RHINOCEROS	CR	I
Eretmochelys imbricata	HAWKSBILL TURTLE	CR	
Paraxerus vincenti	VINCENT'S BUSH SQUIRREL	CR	D
Pristis microdon	FRESHWATER SAWFISH, LARGETOOTH SAWFISH, LEICHHARDT'S SAWFISH, SMALLTOOTH SAWFISH	CR	D
Pristis zijsron	NARROWSNOUT SAWFISH	CR	D
Encephalartos munchii		CR	D
Encephalartos pterogonus		CR	D
Apalis moreaui	LONG-BILLED TAILORBIRD	CR	D
Arthroleptis troglodytes	CAVE SQUEAKER	CR	D
Acrocephalus griseldis	BASRA REED-WARBLER	EN	D
Alethe choloensis	THYOLO ALETHE	EN	D
Ardeola idae	MADAGASCAR POND-HERON	EN	D
Balaenoptera borealis	COALFISH WHALE, POLLACK WHALE, RUDOPHI'S RORQUAL, SEI WHALE	EN	
Bellamya robertsoni		EN	
Caretta caretta	LOGGERHEAD	EN	
Cheilinus undulatus	GIANT WRASSE, HUMPHEAD WRASSE, HUMPHEAD, MAORI WRASSE, NAPOLEON WRASSE, TRUCK WRASSE, UNDULATE WRASSE	EN	D
Chelonia mydas	GREEN TURTLE	EN	D
Epinephelus marginatus	DUSKY GROUPER	EN	D
Lanistes nasutus		EN	
Lanistes nyssanus		EN	
Lanistes solidus		EN	
Lepidochelys olivacea	OLIVE RIDLEY, PACIFIC RIDLEY	EN	
Lycaon pictus	AFRICAN WILD DOG, CAPE HUNTING DOG, PAINTED HUNTING DOG, WILD DOG	EN	D
Pterodroma baraui	BARAU'S PETREL	EN	D
Zoothera guttata	SPOTTED GROUND-THRUSH	EN	D
Warburgia salutaris	MURANGA, PEPPER BARK TREE	EN	
Lovoa swynnertonii	BROWN MAHOGANY, KILIMANJARO MAHOGANY	EN	
Aloe ballii		EN	
Ficus muelleriana		EN	
Thalassarche chlororhynchos	ATLANTIC YELLOW-NOSED ALBATROSS	EN	D
Thalassarche carteri	INDIAN YELLOW-NOSED ALBATROSS	EN	D
Encephalartos chimanimaniensis	CHIMANIMANI CYCAD	EN	D

Scientific Name	Common Name	Class	Population Trend
Encephalartos lebomboensis	LEBOMBO CYCAD	EN	D
Bufo inyangae	INYANGA TOAD	EN	D
Stephopaedes anotis	CHIRINDA TOAD	EN	D
Probreviceps rhodesianus		EN	D
Nothophryne broadleyi		EN	D
Afrana inyangae	INYANGANI RIVER FROG	EN	D
Aetomylaeus vespertilio	ORNATE EAGLE RAY, RETICULATE EAGLE RAY	EN	D
Oreochromis squamipinnis		EN	D
Opsaridium microlepis	LAKE SALMON	EN	D
Oreochromis lidole		EN	D
Oreochromis karongae		EN	D
Aepyceros melampus	IMPALA	LR/cd	S
Alcelaphus lichtensteinii	LICHTENSTEIN'S HARTEBEEST	LR/cd	S
Cephalophus natalensis	NATAL DUIKER, NATAL RED DUIKER, RED FOREST DUIKER	LR/cd	D
Connochaetes taurinus	BLUE & WHITE-BEARDED WILDEBEEST, BLUE WILDEBEEST	LR/cd	D
Crocuta crocuta	SPOTTED HYAENA	LR/cd	U
Damaliscus lunatus	TSESSEBE	LR/cd	D
Eubalaena australis	SOUTHERN RIGHT WHALE	LR/cd	I
Giraffa camelopardalis	GIRAFFE	LR/cd	S
Hippotragus equinus	ROAN ANTELOPE	LR/cd	D
Hippotragus niger	SABLE ANTELOPE	LR/cd	D
Kobus ellipsiprymnus	WATERBUCK	LR/cd	D
Neotragus moschatus	SUNI	LR/cd	S
Orcinus orca	KILLER WHALE, ORCA	LR/cd	
Oreotragus oreotragus	KLIPSPRINGER	LR/cd	D
Ourebia ourebi	ORIBI	LR/cd	D
Raphicerus sharpei	SHARPE'S GRYSBOK	LR/cd	S
Redunca arundinum	SOUTHERN REEDBUCK	LR/cd	S
Stenella coeruleoalba	EUPHROSYNE DOLPHIN, STRIPED DOLPHIN	LR/cd	
Stenella longirostris	LONG-BEAKED DOLPHIN, LONG-SNOUTED DOLPHIN, SPINNER DOLPHIN	LR/cd	
Syncerus caffer	AFRICAN BUFFALO	LR/cd	D
Tragelaphus angasii	NYALA	LR/cd	S
Tragelaphus strepsiceros	GREATER KUDU	LR/cd	S
Tragelaphus oryx	COMMON ELAND, ELAND	LR/cd	S
Tridacna maxima	SMALL GIANT CLAM	LR/cd	
Tridacna squamosa	FLUTED CLAM, FLUTED GIANT CLAM, SCALY CLAM	LR/cd	
Butis butis	DUCKBILL SLEEPER	LR/nt	
Carcharhinus limbatus	BLACKTIP SHARK	LR/nt	U
Carcharhinus obscurus	DUSKY SHARK	LR/nt	D
Carcharhinus plumbeus	SANDBAR SHARK	LR/nt	U
Croilia mossambica	BURROWING GOBY, NAKED GOBY	LR/nt	
Cycloderma frenatum	ZAMBEZI FLAPSHELL TURTLE	LR/nt	

Scientific Name	Common Name	Class	Population Trend
Eleotris melanosoma	BROADHEAD SLEEPER	LR/nt	
Galago zanzibaricus	MATUNDU DWARF GALAGO, ZANZIBAR BUSHBABY, ZANZIBAR GALAGO	LR/nt	U
Glossogobius biocellatus	SLEEPY GOBY	LR/nt	
Hexanchus griseus	BLUNTNOSE SIXGILL SHARK	LR/nt	U
Hyaena brunnea	BROWN HYAENA	LR/nt	U
Kinixys natalensis	NATAL HINGE-BACK TORTOISE, NATAL HINGE-BACKED TORTOISE, NATAL HINGED TORTOISE	LR/nt	
Lanistes elliptus		LR/nt	
Manis temminckii	CAPE PANGOLIN, GROUND PANGOLIN, SCALY ANTEATER, SOUTH AFRICAN PANGOLIN, TEMMINCK'S GROUND PANGOLIN	LR/nt	
Oligolepis keiensis	KEI GOBY	LR/nt	
Papillogobius melanobranchus	BLACKTHROAT GOBY	LR/nt	
Papillogobius reichei	TROPICAL SAND GOBY	LR/nt	
Redigobius dewaali	CHECKED GOBY	LR/nt	
Silhouettea sibayi	SIBAYI GOBY	LR/nt	
Tragelaphus spekii	MARSHBUCK, SITATUNGA	LR/nt	D
Dalbergia melanoxylon	AFRICAN BLACKWOOD, MOZAMBIQUE EBONY	LR/nt	
Pterocarpus angolensis	BLEEDWOOD TREE, KIAAT, MUKWA	LR/nt	
Brachylaena huillensis		LR/nt	
Milicia excelsa		LR/nt	
Croton megalocarpoides		LR/nt	
Haplocoelum trigonocarpum		LR/nt	
Dalbergia bracteolata		LR/nt	
Combretum mkuzense		LR/nt	
Bivinia jalbertii		LR/nt	
Isurus oxyrinchus	SHORTFIN MAKO	LR/nt	U
Hypogaleus hyugaensis	BLACKTIP TOPESHARK	LR/nt	U
Carcharhinus amblyrhynchos	GRAY REEF SHARK	LR/nt	U
Carcharhinus brevipinna	SPINNER SHARK	LR/nt	U
Carcharhinus leucas	BULL SHARK	LR/nt	U
Carcharhinus melanopterus	BLACKTIP REEF SHARK	LR/nt	U
Galeocerdo cuvier	TIGER SHARK	LR/nt	U
Prionace glauca	BLUE SHARK	LR/nt	U
Scoliodon laticaudus	SPADENOSE SHARK	LR/nt	U
Triaenodon obesus	WHITETIP REEF SHARK	LR/nt	U
Sphyrna lewini	SCALLOPED HAMMERHEAD	LR/nt	U
Sphyrna zygaena	SMOOTH HAMMERHEAD	LR/nt	U
Taeniura lymma	BLUE-SPOTTED STINGRAY, BLUESPOTTED RIBBONTAIL RAY	LR/nt	U
Anthreptes reichenowi	PLAIN-BACKED SUNBIRD	NT	
Apalis lynesi	NAMULI APALIS	NT	U
Ceratotherium simum	SQUARE-LIPPED RHINOCEROS, WHITE RHINOCEROS	NT	I
Circaetus fasciolatus	SOUTHERN BANDED SNAKE-EAGLE	NT	I

Scientific Name	Common Name	Class	Population Trend
Circus macrourus	PALLID HARRIER	NT	D
Crex crex	CORNCRAKE	NT	D
Dendropicos stierlingi	STIERLING'S WOODPECKER	NT	D
Falco fasciinucha	TAITA FALCON	NT	
Gallinago media	GREAT SNIPE	NT	
Haematopus moquini	AFRICAN OYSTERCATCHER	NT	
Nycteris woodi	WOOD'S SLIT-FACED BAT	NT	D
Phoenicopterus minor	LESSER FLAMINGO	NT	
Praomys delectorum	DELECTABLE SOFT-FURRED MOUSE, EAST AFRICAN PRAOMYS	NT	S
Rhinolophus blasii	BLASIUS'S HORSESHOE BAT	NT	D
Rhinolophus swinnyi	SWINNY'S HORSESHOE BAT	NT	U
Rhynchocyon cirnei	CHECKERED ELEPHANT SHREW, CHECKERED SENGI	NT	U
Scotophilus nigrita	SCHREBER'S YELLOW BAT	NT	U
Tadarida ventralis	AFRICAN GIANT FREE-TAILED BAT	NT	U
Aetobatus narinari	BONNETRAY, MAYLAN, SPOTTED EAGLE RAY	NT	D
Manta birostris	DEVIL FISH, DEVIL RAY, GIANT MANTA, MANTA RAY, PRINCE ALFRED'S RAY	NT	U
Neotis denhami	STANLEY'S BUSTARD	NT	
Rynchops flavirostris	AFRICAN SKIMMER	NT	
Phalacrocorax capensis	CAPE CORMORANT	NT	
Bulweria fallax	JOUANIN'S PETREL	NT	U
Procellaria cinerea	GREY PETREL	NT	
Ploceus olivaceiceps	OLIVE-HEADED WEAVER	NT	
Centrophorus niaukang	QUELVACHO CHINO, TAIWAN GULPER SHARK	NT	D
Heptranchias perlo	ONE-FINNED SHARK, PERLON SHARK, SEVENGILL COW SHARK, SHARPNOSE SEVENGILL SHARK, SHARPSNOUTED SEVENGILL, SLENDER SEVENGILL	NT	U
Mobula eregoodootenkee	PYGMY DEVILRAY	NT	U
Stangeria eriopus		NT	D
Pliotrema warreni	SIXGILL SAWSHARK	NT	U
Dipturus campbelli	BLACKSPOT SKATE	NT	U
Epinephelus fuscoguttatus	BROWN-MARBLED GROUPER	NT	U
Epinephelus coioides	ESTUARY COD, ORANGE-SPOTTED GROUPER	NT	D
Epinephelus andersoni	BROWN-SPOTTED ROCKCOD, CATFACE ROCKCOD	NT	U
Hipposideros marungensis		NT	D
Miniopterus natalensis	NATAL LONG-FINGERED BAT	NT	U
Proscymnodon plunketi	PLUNKET'S DOGFISH, PLUNKET'S SHARK, WAITE'S DOGFISH	NT	U
Nectarinia neergardi	NEERGAARD'S SUNBIRD	NT	
Coracias garrulus	EUROPEAN ROLLER	NT	
Agapornis lilianae	LILIAN'S LOVEBIRD	NT	
Chlorolestes elegans	ELEGANT SYLPH	NT	U

Scientific Name	Common Name	Class	Population Trend
Hadrothemis scabrifrons	RED JUNGLE-SKIMMER	NT	U
Epinephelus malabaricus	MALABAR GROUPER	NT	D
Epinephelus polyphekadion	CAMOUFLAGE GROUPER	NT	D
Acinonyx jubatus	CHEETAH, HUNTING LEOPARD	VU	D
Aethomys silindensis	SELINDA VELD RAT, SILINDA ROCK RAT	VU	U
Apalis chariessa	WHITE-WINGED APALIS	VU	D
Barbus brevipinnis	SHORTFIN BARB	VU	
Carcharias taurus	GREY NURSE SHARK, SAND TIGER SHARK, SPOTTED RAGGED-TOOTH SHARK	VU	U
Carcharodon carcharias	GREAT WHITE SHARK	VU	U
Chaetodon marleyi	MARLEY'S BUTTERFLYFISH	VU	
Chetia brevis	ORANGE-FRINGED LARGEMOUTH	VU	
Cloeotis percivali	PERCIVAL'S TRIDENT BAT	VU	U
Diomedea exulans	WANDERING ALBATROSS	VU	D
Dugong dugon	DUGONG, SEA COW	VU	U
Egretta vinaceigula	SLATY EGRET	VU	D
Epinephelus lanceolatus	BRINDLE BASS, BRINDLED GROUPER, GIANT GROUPER, QUEENSLAND GROPER	VU	D
Falco naumanni	LESSER KESTREL	VU	D
Grus carunculatus	WATTLED CRANE	VU	D
Gyps coprotheres	CAPE GRIFFON	VU	D
Hippopotamus amphibius	COMMON HIPPOPOTAMUS, HIPPOPOTAMUS, LARGE HIPPO	VU	D
Hirundo atrocaerulea	BLUE SWALLOW	VU	D
Loxodonta africana	AFRICAN ELEPHANT	VU	U
Megaptera novaeangliae	BUNCH, HUMP WHALE, HUMPBACK WHALE, HUNCHBACKED WHALE	VU	I
Morus capensis	CAPE GANNET	VU	D
Panthera leo	AFRICAN LION, LION	VU	D
Rhincodon typus	WHALE SHARK	VU	D
Sheppardia gunningi	EAST COAST AKALAT	VU	D
Spheniscus demersus	AFRICAN PENGUIN	VU	D
Swynnertonia swynnertoni	SWYNNERTON'S ROBIN	VU	D
Thunnus obesus	BIGEYE TUNA	VU	
Ocotea kenyensis		VU	
Euphorbia lividiflora		VU	
Allophylus chirindensis		VU	
Vitellariopsis ferruginea		VU	
Olea chimanimani		VU	
Pleioceras orientale		VU	
Khaya anthotheca	AFRICAN MAHOGANY, WHITE MAHOGANY	VU	
Nauclea diderrichii		VU	
Prunus africana	RED STINKWOOD	VU	
Garcinia acutifolia		VU	
Tannodia swynnertonii		VU	
Bussea xylocarpa		VU	

Scientific Name	Common Name	Class	Population Trend
Acacia purpurea		VU	
Sterculia schliebenii		VU	
Dialium holtzii		VU	
Strychnos mellodora		VU	
Baphia macrocalyx		VU	
Berlinia orientalis		VU	
Guibourtia schliebenii		VU	
Millettia bussei		VU	
Premna schliebenii		VU	
Cola mossambicensis		VU	
Cordia stuhlmannii		VU	
Cordia mandimbana		VU	
Synsepalum kassneri		VU	
Mildbraedia carpinifolia		VU	
Paranecepsia alchorneifolia		VU	
Coffea zanguebariae		VU	
Cuviera tomentosa		VU	
Psydrax micans		VU	
Baphia kirkii		VU	
Premna tanganyikensis		VU	
Pandanus petersii		VU	
Centrophorus granulosus	GULPER SHARK	VU	D
Galeorhinus galeus	LIVER-OIL SHARK, MILLER'S DOG, OIL SHARK, PENNY DOG, RIG, SCHOOL SHARK, SNAPPER SHARK, SOUPFIN, SOUPIE, SOUTHERN TOPE, SWEET WILLIAM, TIBURON, TOPE SHARK, TOPER, TOPE, VITAMIN SHARK, WHITHOUND	VU	D
Rhynchobatus djiddensis	GIANT GUITARFISH, WHITESPOTTED WEDGEFISH	VU	D
Urogymnus asperrimus	PORCUPINE RAY	VU	U
Torgos tracheliotos	LAPPET-FACED VULTURE	VU	D
Macronectes giganteus	SOUTHERN GIANT-PETREL	VU	D
Procellaria aequinoctialis	WHITE-CHINNED PETREL	VU	D
Modulatrix orostruthus	DAPPLE-THROAT	VU	D
Carpitalpa arendsi	AREND'S GOLDEN MOLE	VU	U
Aetomylaeus nichofii	BANDED EAGLE RAY	VU	D
Physeter macrocephalus	CACHELOT, POT WHALE, SPERM WHALE, SPERMACET WHALE	VU	
Nebrius ferrugineus	TAWNY NURSE SHARK	VU	D
Rhina ancylostoma	BOWMOUTH GUITARFISH, MUD SKATE, SHARK RAY	VU	D
Hemipristis elongatus	FOSSIL SHARK, SNAGGLETOOTH SHARK	VU	D
Stegostoma fasciatum	LEOPARD SHARK, ZEBRA SHARK	VU	D
Encephalartos aplanatus		VU	D
Encephalartos gratus	MULANJE CYCAD	VU	D
Encephalartos manikensis	GORONGOWE CYCAD	VU	D
Encephalartos ngoyanus	NGOYE CYCAD	VU	D

Scientific Name	Common Name	Class	Population Trend
Encephalartos senticosus		VU	D
Encephalartos umbeluziensis	UMBELUZI CYCAD	VU	D
Epinephelus albomarginatus	CAPTAIN FINE, WHITE-EDGED ROCKCOD	VU	D
Lissonycteris goliath	HARRISON'S FRUIT BAT	VU	D
Glareola ocularis	MADAGASCAR PRATINCOLE	VU	D
Strongylopus rhodesianus	CHIMANIMANI STREAM FROG	VU	D
Coryphagrion grandis		VU	U
Nepogomphoides stuhlmanni		VU	U
Rhinoptera javanica	FLAPNOSE RAY, JAVANESE COWNOSE RAY	VU	U
Taeniura meyeni	BLACK-BLOTCHED STINGRAY, BLACK-SPOTTED STINGRAY, BLOTCHED FANTAIL RAY, FANTAIL STINGRAY, GIANT REEF RAY, ROUND RIBBONTAIL RAY, SPECKLED STINGRAY	VU	U
Opsaridium microcephalum		VU	D
Haplochromis tweddlei		VU	U
Copadichromis geertsi		VU	U
Copadichromis trewavasae		VU	U
Copadichromis verduyni		VU	U
Iodotropheus stuartgranti		VU	U
Aulonocara hansbaenschi	AULONOCARA FORT MAGUIRE	VU	U
Maylandia aurora		VU	U
Maylandia phaeos		VU	U
Nothobranchius orthonotus	SPOTTED KILLIFISH	VU	U

Key	
CR	Critically Endangered
EN	Endangered
LR/cd	Low Risk: Conservation Dependent
LR/nt	Near Threatened
NT	Near Threatened
VU	Vulnerable
I	Increasing
D	Decreasing

Annex 7: EU MRLs for DDT

According to the Pesticides Safety Directorate of the United Kingdom, MRLs are defined as "the maximum concentration of pesticide residue (expressed as milligrams of residue per kilogram of commodity) likely to occur in or on food commodities and animal feeds after the use of pesticides according to Good Agricultural Practice (GAP)" (2006).

MRLs are based on residue levels, which result from the approved use of the pesticide, and are set at a level that is as low as possible whilst accommodating the GAP. They are intended primarily as a check that GAP is being followed and to assist international trade in produce treated with pesticides.

The limit of determination (LOD) is the lowest concentration of a pesticide residue that can be measured using routine analysis.

Proper use of a pesticide can leave small traces of residue on the commodity at harvest; therefore, many MRLs are set above the LOD. There are, however, three possible reasons why the MRL might be set at the LOD:

- A particular use is not "supported" in the EU – either because insufficient data have been provided or because no use is intended.
- Scientific data shows that the intended use might leave residues that would pose an unacceptable risk to consumers.
- Scientific data shows that the intended use leaves no determinable residues on the treated commodity at harvest. This could be in cases where, for example, the pesticide is used at early stages of growth as a pre-emergence herbicide or as a seed treatment.

An MRL at the LOD does not necessarily mean that the pesticide use is illegal.

http://www.pesticides.gov.uk/home.asp

EU MRLs for DDT			
Crop Group	**Commodity**	**Maximum Residue Limit (MRL)**	**Limit of Determination (LOD)**
CITRUS	Citrus Fruit Others	0.05	0.05
CITRUS	Grapefruit	0.05	0.05
CITRUS	Lemons	0.05	0.05
CITRUS	Limes	0.05	0.05
CITRUS	Mandarins	0.05	0.05
CITRUS	Oranges	0.05	0.05
CITRUS	Pomelo	0.05	0.05
TREE NUTS	Almonds	0.05	0.05
TREE NUTS	Brazil Nuts	0.05	0.05
TREE NUTS	Cashew Nuts	0.05	0.05
TREE NUTS	Chestnuts	0.05	0.05
TREE NUTS	Coconuts	0.05	0.05
TREE NUTS	Hazelnuts	0.05	0.05
TREE NUTS	Macadamia Nuts	0.05	0.05
TREE NUTS	Pecans	0.05	0.05
TREE NUTS	Pine Nuts	0.05	0.05
TREE NUTS	Pistachios	0.05	0.05
TREE NUTS	Tree Nuts Others	0.05	0.05
TREE NUTS	Walnuts	0.05	0.05
POME FRUIT	Apples	0.05	0.05
POME FRUIT	Pears	0.05	0.05
POME FRUIT	Pome Fruit Others	0.05	0.05
POME FRUIT	Quinces	0.05	0.05
STONE FRUIT	Apricots	0.05	0.05
STONE FRUIT	Cherries	0.05	0.05
STONE FRUIT	Peaches	0.05	0.05
STONE FRUIT	Plums	0.05	0.05
STONE FRUIT	Stone Fruit Others	0.05	0.05
BERRIES AND SMALL FRUIT	Bilberries	0.05	0.05
BERRIES AND SMALL FRUIT	Blackberries	0.05	0.05
BERRIES AND SMALL FRUIT	Cane Fruit Others	0.05	0.05
BERRIES AND SMALL FRUIT	Cranberries	0.05	0.05
BERRIES AND SMALL FRUIT	Currants (Black, Red and White)	0.05	0.05
BERRIES AND SMALL FRUIT	Dewberries	0.05	0.05
BERRIES AND SMALL FRUIT	Gooseberry	0.05	0.05
BERRIES AND SMALL FRUIT	Loganberries	0.05	0.05
BERRIES AND SMALL FRUIT	Other Small Fruit and Berries-Others	0.05	0.05

EU MRLs for DDT			
Crop Group	**Commodity**	**Maximum Residue Limit (MRL)**	**Limit of Determination (LOD)**
BERRIES AND SMALL FRUIT	Raspberries	0.05	0.05
BERRIES AND SMALL FRUIT	Strawberries	0.05	0.05
BERRIES AND SMALL FRUIT	Table Grapes	0.05	0.05
BERRIES AND SMALL FRUIT	Wild Berries and Wild Fruit	0.05	0.05
BERRIES AND SMALL FRUIT	Wine Grapes	0.05	0.05
MISCELLANEOUS FRUIT	Avocados	0.05	0.05
MISCELLANEOUS FRUIT	Bananas	0.05	0.05
MISCELLANEOUS FRUIT	Dates	0.05	0.05
MISCELLANEOUS FRUIT	Figs	0.05	0.05
MISCELLANEOUS FRUIT	Kiwi Fruit	0.05	0.05
MISCELLANEOUS FRUIT	Kumquats	0.05	0.05
MISCELLANEOUS FRUIT	Litchis	0.05	0.05
MISCELLANEOUS FRUIT	Mangoes	0.05	0.05
MISCELLANEOUS FRUIT	Miscellaneous Fruit Others	0.05	0.05
MISCELLANEOUS FRUIT	Olives	0.05	0.05
MISCELLANEOUS FRUIT	Passion Fruit	0.05	0.05
MISCELLANEOUS FRUIT	Pineapples	0.05	0.05
MISCELLANEOUS FRUIT	Pomegranates	0.05	0.05
ROOT AND TUBER VEGETABLES	Beetroot	0.05	0.05
ROOT AND TUBER VEGETABLES	Carrots	0.05	0.05
ROOT AND TUBER VEGETABLES	Celeriac	0.05	0.05
ROOT AND TUBER VEGETABLES	Horseradish	0.05	0.05
ROOT AND TUBER VEGETABLES	Jerusalem artichoke	0.05	0.05
ROOT AND TUBER VEGETABLES	Parsley root	0.05	0.05
ROOT AND TUBER VEGETABLES	Parsnips	0.05	0.05
ROOT AND TUBER VEGETABLES	Radishes	0.05	0.05
ROOT AND TUBER VEGETABLES	Root and Tuber Vegetables others	0.05	0.05
ROOT AND TUBER VEGETABLES	Salsify	0.05	0.05
ROOT AND TUBER VEGETABLES	Swedes	0.05	0.05
ROOT AND TUBER VEGETABLES	Sweet potato	0.05	0.05
ROOT AND TUBER VEGETABLES	Turnip	0.05	0.05
ROOT AND TUBER VEGETABLES	Yams	0.05	0.05

EU MRLs for DDT			
Crop Group	**Commodity**	**Maximum Residue Limit (MRL)**	**Limit of Determination (LOD)**
BULB VEGETABLES	Bulb Vegetables others	0.05	0.05
BULB VEGETABLES	Garlic	0.05	0.05
BULB VEGETABLES	Onions	0.05	0.05
BULB VEGETABLES	Shallots	0.05	0.05
BULB VEGETABLES	Spring onion	0.05	0.05
FRUITING VEGETABLES	Aubergine	0.05	0.05
FRUITING VEGETABLES	Courgettes	0.05	0.05
FRUITING VEGETABLES	Cucumbers	0.05	0.05
FRUITING VEGETABLES	Cucurbits edible peel others	0.05	0.05
FRUITING VEGETABLES	Cucurbits inedible peel others	0.05	0.05
FRUITING VEGETABLES	Gherkins	0.05	0.05
FRUITING VEGETABLES	Melons	0.05	0.05
FRUITING VEGETABLES	Peppers	0.05	0.05
FRUITING VEGETABLES	Solanacea others	0.05	0.05
FRUITING VEGETABLES	Squashes	0.05	0.05
FRUITING VEGETABLES	Sweet corn	0.05	0.05
FRUITING VEGETABLES	Tomatoes	0.05	0.05
FRUITING VEGETABLES	Watermelons	0.05	0.05
BRASSICA VEGETABLES	Broccoli	0.05	0.05
BRASSICA VEGETABLES	Brussels sprouts	0.05	0.05
BRASSICA VEGETABLES	Cauliflower	0.05	0.05
BRASSICA VEGETABLES	Chinese cabbage	0.05	0.05
BRASSICA VEGETABLES	Flowering brassicas others	0.05	0.05
BRASSICA VEGETABLES	Head brassicas others	0.05	0.05
BRASSICA VEGETABLES	Head cabbages	0.05	0.05
BRASSICA VEGETABLES	Kale	0.05	0.05
BRASSICA VEGETABLES	Kohlrabi	0.05	0.05
BRASSICA VEGETABLES	Leafy brassicas others	0.05	0.05
LEAFY VEGETABLES	Beet leaves (chard)	0.05	0.05
LEAFY VEGETABLES	Celery leaves	0.05	0.05
LEAFY VEGETABLES	Chervil	0.05	0.05
LEAFY VEGETABLES	Chives	0.05	0.05
LEAFY VEGETABLES	Cress	0.05	0.05
LEAFY VEGETABLES	Herbs others	0.05	0.05
LEAFY VEGETABLES	Lamb's lettuce	0.05	0.05
LEAFY VEGETABLES	Lettuce	0.05	0.05
LEAFY VEGETABLES	Lettuce and similar others	0.05	0.05
LEAFY VEGETABLES	Parsley	0.05	0.05
LEAFY VEGETABLES	Scarole	0.05	0.05
LEAFY VEGETABLES	Spinach	0.05	0.05
LEAFY VEGETABLES	Spinach and similar (others)	0.05	0.05
LEAFY VEGETABLES	Watercress	0.05	0.05
LEAFY VEGETABLES	Witloof	0.05	0.05

EU MRLs for DDT			
Crop Group	**Commodity**	**Maximum Residue Limit (MRL)**	**Limit of Determination (LOD)**
LEGUME VEGETABLES (FRESH)	Beans (with pods)	0.05	0.05
LEGUME VEGETABLES (FRESH)	Beans (without pods)	0.05	0.05
LEGUME VEGETABLES (FRESH)	Legume vegetables fresh others	0.05	0.05
LEGUME VEGETABLES (FRESH)	Peas (with pods)	0.05	0.05
LEGUME VEGETABLES (FRESH)	Peas (without pods)	0.05	0.05
STEM VEGETABLES (FRESH)	Asparagus	0.05	0.05
STEM VEGETABLES (FRESH)	Cardoons	0.05	0.05
STEM VEGETABLES (FRESH)	Celery	0.05	0.05
STEM VEGETABLES (FRESH)	Fennel	0.05	0.05
STEM VEGETABLES (FRESH)	Globe artichoke	0.05	0.05
STEM VEGETABLES (FRESH)	Leeks	0.05	0.05
STEM VEGETABLES (FRESH)	Rhubarb	0.05	0.05
STEM VEGETABLES (FRESH)	Stem vegetables fresh others	0.05	0.05
FUNGI	Cultivated mushrooms	0.05	0.05
FUNGI	Wild mushrooms	0.05	0.05
PULSES	Beans	0.05	0.05
PULSES	Lentils	0.05	0.05
PULSES	Peas	0.05	0.05
PULSES	Pulses others	0.05	0.05
OILSEEDS	Cotton seed	0.05	0.05
OILSEEDS	Linseed	0.05	0.05
OILSEEDS	Mustard seed	0.05	0.05
OILSEEDS	Oilseeds others	0.05	0.05
OILSEEDS	Peanuts	0.05	0.05
OILSEEDS	Poppy seeds	0.05	0.05
OILSEEDS	Rapeseed	0.05	0.05
OILSEEDS	Sesame seeds	0.05	0.05
OILSEEDS	Soya bean	0.05	0.05
OILSEEDS	Sunflower seeds	0.05	0.05
POTATOES	Early potatoes	0.05	0.05
POTATOES	Ware potatoes	0.05	0.05
TEA	Tea	0.2	0.05
HOPS	Hops (dried)	0.05	0.05
CEREALS	Barley	0.05	
CEREALS	Buckwheat	0.05	
CEREALS	Cereals others	0.05	

EU MRLs for DDT			
Crop Group	**Commodity**	**Maximum Residue Limit (MRL)**	**Limit of Determination (LOD)**
CEREALS	Maize	0.05	
CEREALS	Millet	0.05	
CEREALS	Oats	0.05	
CEREALS	Rice	0.05	
CEREALS	Rye	0.05	
CEREALS	Sorghum	0.05	
CEREALS	Triticale	0.05	
CEREALS	Wheat	0.05	
MEAT	0201 Bovine	1	
MEAT	0202 Bovine, frozen	1	
MEAT	0203 Swine	1	
MEAT	0204 Sheep or goats	1	
MEAT	0205 00 00 Horses, asses, mules,...	1	
EDIBLE OFALL	0206 Bovines,swine,sheep,goats,...	1	
FAT	0209 00 Pig & poultry	1	
DAIRY	0401Milk & cream	0.04	
DAIRY	0402 Milk & cream	0.04	
DAIRY	0405 00 Butter, other fats, oils...	0.04	
DAIRY	0406 Cheese & curd	0.04	
EGG	0407 00 Eggs in shell	0.05	
EGG	0408 Eggs (not in shell) & yolks	0.05	
MEAT, OFFAL & BLOOD	1601 00 Sausage & similar	1	
MEAT, OFFAL & BLOOD	1602 Meat offal or blood (others)	1	
MEAT & EDIBLE OFFAL	0207 Poultry of heading NÂ°0105	1	
MEAT & EDIBLE OFFAL	0210 Edible flours & meals;...	1	
MEAT & EDIBLE OFFAL	ex0208 Oth. meat & edible meat offal	1	

http://europa.eu.int/comm/food/plant/protection/resources/mrl_pesticide.pdf