INITIAL ENVIRONMENTAL EXAMINATION: AMENDMENT

PESTICIDE EVALUATION REPORT AND SAFER USE ACTION PLAN (PERSUAP) FOR INDOOR RESIDUAL SPRAYING (IRS) FOR MALARIA CONTROL IN KABALE DISTRICT, UGANDA

PROGRAM/ACTIVITY DATA:

Program/Activity Number: 936-3100-17, Bureau for Global Health
671-008, Uganda

Country/Region: Uganda/Africa Bureau/East Africa

Program/Activity Title: SO 8: Improved Human Capacity
Sub-activity: IRS for Malaria Control in Kabale District, SW Uganda

Funding Begin: FY06 Funding End: FY07 LOP Amount: $1.7 million (not yet disbursed)

PERSUAP Prepared By: Melanie Biscoe and Gunawardena Dissanayake, RTI International, and Jody Stallings, MEO, USAID/Uganda

Current Date: March 8, 2006

ENVIRONMENTAL ACTION RECOMMENDED: (Place X where applicable)
Categorical Exclusion: ____ Negative Determination: _X__
Positive Determination: ____ Deferral: ____

ADDITIONAL ELEMENTS: (Place X where applicable)
CONDITIONS: _X__ PVO/NGO: ____

IEE Amendment (Y/N): Y. Filename & date of original IEE: 34Uganda3_SO8_amend.doc, 6/14/04

Other Relevant Environmental Compliance Documentation: This IEE references the following USAID environmental compliance documentation that is already in effect for ongoing activities under USAID/Uganda SO 8:

- *Urban Malaria Control Project* to *field test the use of two microbiological larvicides:* 34Uganda2_Bt_Exception_SO8amend.doc, 05/18/2004.
- *Pesticide Evaluation Report And Safer Use Action Plan Insecticide Treated Materials In Uganda:* USAID/Uganda34Uganda1_SO8_ITN_PERSUAP.doc, 11/17/2003

SUMMARY OF FINDINGS:

This program is associated with the U.S. President's Initiative on Malaria (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 Initiative will support and complement efforts of the Global Fund, the World Bank, and other members of the Roll Back Malaria Partnership. The Initiative will include detailed

reporting on inputs, outputs, and results. Angola, Tanzania, and Uganda are the first three countries selected for this Initiative.

As part of a new malaria control program under the PMI, USAID proposes to implement indoor residual spraying (IRS) in Kabale District, Uganda, for vector control using ICON™ WP (active ingredient lambda-cyhalothrin) in June to July, 2006 and January to February, 2007 (latter date tentative). This District is epidemic-prone and IRS would be used as an epidemic prevention strategy. Another aspect of malaria vector control supported by the Ministry of Health includes Insecticide Treated Nets (ITN)s that are being sold/distributed within the district, although further scale-up is needed. At this time, USAID is not sponsoring ITN distribution in Kabale District. If it were to do so, the provisions of the Uganda ITN PERSUAP will be invoked (see above). USAID is currently sponsoring the distribution of 300,000 ITNs in Northern Uganda. 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 IEE/PERSUAP.

USAID-Uganda is committed to the implementation of the National Malaria Control and Prevention (NMCP) five-year Strategic Plan 2001/2-2004/5 to combat malaria, supported by the Roll Back Malaria (RBM) global movement, in which ITNs and now IRS play a central role in the disease prevention strategy.

In Uganda, ICON™ WP has been approved for use in public health. The Drug Inspectorate Department at the National Drug Authority can ensure quality control of incoming insecticides upon request. *Only ICON™ 10% WP is hereby proposed for USAID supported IRS interventions in Kabale District.*

USAID support for malaria epidemic prevention in Kabale District, Uganda, will include a biannual indoor residual spraying (IRS) Program with the following components:

- Purchase of insecticide (ICON™ 10% WP lambda-cyhalothrin), spraying equipment (Hudson X-Pert® sprayers), and adequate amounts of personal protective clothing and equipment for spray operators and wash persons;
- Financial support for trainers, spray teams, and transport;
- Financial support for storage facility construction and renovation;
- Technical advisors to plan the program, train field staff, and supervise field operations;
- Analysis to identify epidemic risk-prone parishes in Kabale;
- Health education to raise public awareness and promote cooperation; and
- Additional human health and environmental safety components.

This USAID support is part of a Uganda Ministry of Health (MOH) initiative to develop capacity for indoor residual spraying in epidemic-prone areas of the country (primarily in southwestern Uganda). The Uganda National Malaria Control Program (NMCP), with USAID support, will conduct spray operations in Kabale District in June and July of 2006, and potentially January and February of 2007. Uganda hopes to scale up its IRS operations to three epidemic-prone districts in 2007, then expand IRS operations to approximately 15 epidemic-prone districts in 2008.

The Initial Environmental Examination (IEE) for the parent USAID/Uganda's SO 8: Improved Human Capacity includes interventions in preventive health care services including malaria prevention (amended and approved 6/14/2004), and specified a Negative Determination with Conditions for the malaria control via social marketing of ITNs. The condition for ITN and LLITN use was preparation of a brief PERSUAP based on USAID's pesticide procedures (22CFR216.3(b)), in accordance with the Africa Bureau's Programmatic Environmental Assessment of ITN Use in Africa (2001). However, it did not specify the use of Interior Residual Spraying to be undertaken by the Mission's health program.

An IEE approved in May 2004 addressed pilot-scale urban Malaria Control Project to field test the use of two microbiological larvicides, *Bacillus thuringiensis var. israelensis* (Bti) and *Bacillus sphericus* (Bs) (34Uganda2_Bt_Exception_SO8amend.doc).

On the basis of the present and amended PERSUAP of USAID Uganda's new proposed malaria control programs using IRS, a **Negative Determination with Conditions** is recommended for IRS activities in Kabale. This PERSUAP addresses USAID's Pesticide Procedures pursuant to 22 CFR216.3 (b)(1)(i)(a – l) and with the approval of this Final Action Form, explicitly permits the acquisition and use of l-cyhalothrin 10% WP (ICON™) insecticide in IRS. Table 1 specifies Recommended Mitigation Measures as part of a Safer Use Action Plan, and Annex 1 presents the Recommended Mitigation Activities by Programming Sequence. This will also include measures to address pilferage of insecticide for unintended uses, and to counter potential problems with insecticide quality and resistance, which would decrease effectiveness of the insecticide, lessening impact on malaria incidence An overview of conditions of the PERSUAP is detailed below. The **conditions** to this PERSUAP are as follow:

1. The *Safer Use Action Plan is to be implemented with relevant partners as a management tool* for dealing with and accomplishing the objectives. The SUAP:

- Specifies the tasks or steps necessary to achieve the objective;
- Addresses potential difficult issues or problems in implementation (with ways to solve them);
- Looks at cross-functional impacts of actions; and
- Includes a schedule with deadlines for the most important actions, the resources necessary to achieve the objective, and ways or methods to measure the objective(s).

2. A *central storage facility in the district will be remodeled according to FAO standards.* The facility is located in a locked, guarded transport yard in Kabale Town. 20 sub-counties in Kabale District will each be supplied with 2 cargo containers: one for insecticide/sprayer storage, one for a storekeeper office and storage of personal protection equipments. Containers will be located at sub-county government offices, where security is highest. Containers will be outfitted based on FAO standards, and double-padlocking will reduce risk of pilferage.

3. *IRS supervisors, team leaders, and spray operators will be trained* according to WHO standards. Insecticide poisoning management training will be provided to Kabale Regional Health physicians and Health Center III (HCIII) health workers. Insecticide storage facility storekeepers will also be trained on proper stores management.

4. *Occupational exposure to lambda-cyhalothrin will be minimized* through personal protective equipment (according to WHO specs). Either a commercial laundry will be hired to wash all spray operator overalls during the program, or a wash-person (wearing apron, gloves, boots) will be hired to wash overalls at the sub-county storage location at the end of every day of spraying. To minimize prenatal exposure to lambda-cyhalothrin, women sprayers will undergo pregnancy tests prior to spray period. Treatment medications will be provided to Kabale Regional Hospital and HCIIIs in the case of hazardous occupational or residential exposure. An IEC Campaign will educate villagers on their roles and responsibilities during the spray campaign to avoid exposure, and supervisors will remind residents of these responsibilities during spray campaign.

5. *Spraying will not take place in protected and environmentally sensitive areas* (e.g. non-cultivated wetlands). As Kabale District is an extremely important area environmentally, care *will* be taken to ensure lambda-cyhalothrin does not negatively impact sensitive areas. As far as possible, contaminated waste-water/rinse-water will be re-used in subsequent days of spraying (progressive rinsing).

6. An *environmental reporting system* will be developed and implemented, and *environmental monitoring* may also be conducted.

7. *Contaminated sachets will be triple-rinsed and disposed by incineration* at an in-country power plant or cement kiln. According to FAO guidelines, a high-temperature incinerator for disposal of packaging is not necessary for ICON™ WP.

8. *An Environmental Assessment will be prepared prior to use of DDT in IRS operations*. The Uganda MOH proposes to start planning for the carefully-controlled use of DDT in IRS operations. Upon completion of environmental review by Uganda's National Environmental Management Authority (NEMA), use of DDT is expected to begin in 2007. An EA on DDT use has been prepared for MOH as required by NEMA. This EA will be duly reviewed by USAID, revised as necessary and duly approved by USAID before any consideration is given to supporting very specific application of DDT under epidemiologically justified conditions.

As required by ADS 204.5.4, *the SO team must actively monitor ongoing activities for compliance with approved IEE/PERSUAP recommendations,* and modify or end activities that are not in compliance. If additional activities are added to this program which are not described in this document, an amended environmental examination must be prepared. For example, any activities USAID supports to directly or indirectly influence other vector management interventions (larval control, other IVM interventions, etc.) will require an amendment of this examination or subsequent examination to likewise address the requirements of the Pesticide Procedures for such additional uses. The SO team will also ensure that provisions in this IEE for mitigative measures and the conditions specified herein, along with the requirement to monitor, will be incorporated as appropriate in RFA/RFPs, APSs, contracts, cooperative agreements, grants and sub-grants.

APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED:

CLEARANCE:

Mission Director, USAID Uganda: _____Date: _____
Margot Ellis

CONCURRENCE:

Environmental Officer, Bureau of Global Health: _____Date: _____
Michael Zeilinger

ADDITIONAL CLEARANCES:

Mission Environmental Officer
USAID/Uganda: _____ Date: _____
Jody Stallings

Sr. Regional Environmental
Advisor, USAID/REDSO: __Revised & cleared by e-mail _____ Date: 3/24/2006
Walter I. Knausenberger

Environmental Officer
Africa Bureau: _____ Date: _____
Brian D. Hirsch

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by

Melanie Biscoe and Gunawardena Dissanayake, Resarch Triangle Institute International, and Jody Stallings, MEO, USAID/Uganda

March 2006

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ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
C	Celsius
CDC	US Centers for Disease Control and Prevention
DDT	Dichloro-diphenyl-trichloroethane
DHO	District Health Office
DVBD	Division of Vector Borne Disease
EANHS	East Africa Natural History Society
EM	Environmental Management
FAO	Food and Agriculture Organization
GFATM	The Global Fund to Fight AIDS, Tuberculosis, and Malaria (referenced as "Global Fund")
GIS	Geographic Information Systems
GOU	Government of Uganda
HCIII	Health Center III
HIMAL	Highland Malaria Project
IEC	Information, Education and Communication
IEE	Initial Environmental Examination
IPCS	International Programme on Chemical Safety
IRS	Indoor Residual Spraying
ITNs	Insecticide Treated Nets
IVM	Integrated Vector Management
KAP	Knowledge, Attitudes and Practice
mm	millimeter
MOH	Ministry of Health
MRL	Minimal Risk Level
NEMA	National Environmental Management Authority
NMCP	National Malaria Control Program
PERSUAP	Pesticide Evaluation Report and Safer Use Action Plan (USAID)
PMI	Presidential Initiative on Malaria in Africa (U.S.)
PPE	Personal Protective Equipment
RTI	Research Triangle Institute
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WP	Wettable Powder
WHO	World Health Organization
WHO AFRO	World Health Organization Regional Office for Africa
WHOPES	World Health Organization Pesticide Evaluation Scheme

SUMMARY AND CONTEXT

This program is associated with the U.S. President's Initiative on Malaria in Africa, launched in 2005, which seeks to reduce malaria mortality by 50% in up to 15 countries. The Initiative supports and complements efforts of the Global Fund, the World Bank, and other members of the Roll Back Malaria Partnership. The Initiative will include detailed reporting on inputs, outputs, and results. Angola, Tanzania, and Uganda are the first three countries selected for this Initiative.

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- Financial support for storage facility construction and renovation;
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- Analysis to identify epidemic risk-prone parishes in Kabale;
- Health education to raise public awareness and promote cooperation; and
- Additional human health and environmental safety components.

This USAID support is part of a Uganda Ministry of Health (MOH) initiative to develop capacity for indoor residual spraying in epidemic-prone areas of the country (primarily in southwestern Uganda). The Uganda National Malaria Control Program (NMCP), with USAID support, will conduct spray operations in Kabale District in June and July of 2006, and potentially January and February of 2007. Uganda hopes to scale up its IRS operations to three epidemic-prone districts in 2007, then expand IRS operations to approximately 15 epidemic-prone districts in 2008. Upon completion of environmental review by Uganda's National Environmental Management Authority (NEMA), the MOH will start planning for the use of DDT in IRS operations. Use of DDT is expected to begin in 2007.

Since Global Fund financing has been restored to Uganda, Global Fund monies may be used to support IRS operations. USAID should collaborate with the MOH and Global Fund to ensure that actions are complementary and efforts are not duplicated.

In addition to IRS, the NMCP promotes the use of ITNs for malaria vector control. The main focus of the NMCP's ITN strategy is:

- Creation of demand for nets and insecticides
- Ensuring availability of affordable quality nets and insecticides in urban and rural retail outlets
- Provision of subsidized ITNs to vulnerable groups
- Promoting correct use of ITNs and maintenance of their effectiveness

USAID is currently sponsoring the distribution of 300,000 ITNs in Northern Uganda. USAID is not currently sponsoring ITN distribution in Kabale District.

Larviciding is rarely used for malaria vector control, and has not been adopted as an IVM strategy by the MOH. The MOH also has not adopted environmental management as a malaria vector control strategy, although this strategy has been used on a trial basis in recent years. Aside from ITNs and IRS, the Malaria Control Strategic Plan 2001/2-2004/5 states that "other vector control approaches will be encouraged where appropriate" (page 15). USAID is not currently sponsoring use of larviciding or environmental management in Kabale District.

This PERSUAP is intended to guide the mitigation of any harmful human health and environmental effects that could occur as a result of IRS using lambda-cyhalothrin. 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, vehicles, and storage facilities for chemicals not sanctioned by USAID, and that could have harmful health and environmental effects.

RECOMMENDED MITIGATION MEASURES: The Safer Use Action Plan

Table 1 describes the potential negative activities and/or impacts of the operation, their respective mitigation activities, and parties responsible for those mitigation activities. The recommended mitigation actions are also summarized in Annex 1, according to the time that the actions should be taken. Upon signature of this PERSUAP, it is understood that the recommended mitigation activities are to be implemented during the planning and implementation of the Program. The only exceptions to this are the recommended mitigation activities under the "Future Activities" subheading.

Table 1. Recommended Mitigation Activities for IRS Program, Kabale District.

Key	
	Recommended mitigation actions
	Repeat Recommended mitigation actions

Potential Negative Activities/Impacts	Recommended Mitigation Actions	Responsible Parties[1]
Daily Operations		
Occupational exposure to insecticide from daily IRS operations	Training of spray operators, team leaders and supervisors according to WHO and H.D. Hudson Manufacturing Company guidelines.	RTI & Supervisors
	Procurement and proper use of Personal Protective Equipment (PPE) by spray operators, team leaders and supervisors (cotton overalls, face mask, broad-rimmed hat, rubber gloves, gum boots)	Logistics Coordinator, Supervisors
	Training of health workers in insecticide poisoning treatment	Kabale Regional Hospital, MOH, RTI
	Procurement and distribution of treatment medicines for insecticide exposure	MOH and DHO
	Daily on-site personal washing (post-spraying)	Supervisors
	Reprimand of spray operators that do not follow proper procedure in all aspects of operations (handling, spraying, hygiene, cleanup)	Supervisors,DHO, Program Manager
	Hire of commercial laundry or local wash persons (can be spray operators) for proper washing of overalls.	Logistics Coordinator, DHO

[1] RTI will ensure that appropriate training and followup will be provided so that responsible parties have the capacity to conduct or oversee these actions.

	Daily washing of overalls (post-spraying)	Wash Person or Commercial Washing Facility, Supervisor
	If a wash person is hired to clean spray operator PPE, then procurement and wear of PPE by wash person (chemical apron, rubber boots, rubber gloves)	RTI, Supervisors
	Procurement and distribution of barrels for progressive rinse, and wash-tubs for overall washing and personal hygiene	Logistics Coordinator
	Progressive rinse of sprayers and PPE	Supervisors
Fetal exposure to insecticide from daily IRS operations (pertaining to female spray operators)	Development and implementation of environmental reporting system	RTI, Program Manager, Supervisors
	Pregnancy tests during initial hiring of spray operators	Program Manager, Logistics Coordinator, Kabale Regional Hospital
	Distribution of condoms to women spray operators	Logistics Coordinator, Kabale Regional Hospital
	Pregnancy tests one month into spray campaign	Logistics Coordinator, Kabale Regional Hospital
Community and environmental exposure to insecticide from daily IRS operations	Prohibition of spraying in homes where pregnant women are living and cannot move outside the home and stay outside the home during and 1 hour after spraying	Supervisors
	Development and implementation of environmental reporting system	RTI, Program Manager, Supervisors
	Prohibition of spraying in protected areas/sensitive ecosystems (e.g. non-cultivated wetlands), and spraying with care in residential areas where beekeeping occurs	Supervisors
	Prohibition of spraying in homes where sick persons or pregnant women are living and cannot move outside the home *and* stay outside the home during and 1 hour after spraying	Supervisors
	Prohibition of 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.	Supervisors
	IEC Campaign, citing importance of removing all food, 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	DHO and Subcontractor
	Procurement of seat covers or sheets for covering cloth vehicle seats	Logistics Manager
	Cover cloth interior seats of program vehicles with seat cover or cloth to prevent seat contamination	Driver

Procurement and use of gloves for washing interior and exterior of program vehicle	RTI, Supervisor, Driver
Prior to exterior washing of program vehicles, wipe contaminated bed of truck with damp cloth	Driver
End-of-program cleaning/decontamination of interior and exterior of vehicle	Driver
End-of-campaign washing of seat covers and damp cloths used to wipe seats/bed of program vehicle	Wash Person or Commercial Washing Facility, Supervisor
Prior to spraying, covering furniture that cannot be moved with cloths provided by the MOH, District Health Office, or Program (RTI/USAID)	Spray Operator, Supervisor
Reprimand of spray operators that do not follow proper procedure in all aspects of operations (handling, spraying, hygiene, cleanup)	Supervisors, DHO, Program Manager
Daily washing of cloths used to cover furniture	Wash Person or Commercial Washing Facility, Supervisor
Training of spray operators, team leaders and supervisors according to WHO and H.D. Hudson Manufacturing Company guidelines.	RTI & Supervisors
Procurement and distribution of barrels for progressive rinse, and wash-tubs for overall washing and personal hygiene	Logistics Coordinator
Progressive rinsing of sprayers and PPE	Supervisors
Procurement and distribution of materials necessary for collection (in the case of using a commercial laundry for washing spray operator overalls) and decontamination of washtub rinse-water	Logistics Coordinator
Daily collection of laundry rinse-water (from commercial laundry), decontamination of laundry rinse-water, and latrine disposal.	Supervisors
Analysis of decontaminated rinse-water to determine levels of active ingredient.	Logistics Coordinator and Subcontractor
Storage of all insecticides, empty packaging, barrels and tubs in storage facilities, reducing use of contaminated goods domestically	Supervisors and/or storekeeper(s)
Inscription of ALL program barrels and tubs as District Health Office property, and labeling with poison stickers, to deter sale and domestic use in event of pilferage	Logistics Coordinator, District Health Office, MOH.
Daily triple-rinsing of contaminated packaging	Supervisors
Shredding of packaging materials, making them unusable (unless barrels used for progressive rinse)	Supervisors

	Transport of rinsed packaging materials to power plant or cement kiln	Logistics Coordinator (MOH and power plant/cement kiln managers need to coordinate)
	Development and implementation of environmental monitoring plan	RTI, Subcontractor
	Development of protocol for decision-making when environmental monitoring indicates environmental contamination as a result of IRS (suggested protocol involves MOH, NEMA, and MOA stakeholder consultation at the District level)	Program Manager, MOH/NMCP, DHO, NEMA, MOA
	Development and implementation of environmental reporting system	RTI, Program Manager, Supervisors
Special Circumstances		
Pilferage of Insecticide, consequential human and environmental exposure	Renovation of central storage facility	Logistics Coordinator, MOH/NMCP and DHO
	Purchase and renovation of cargo containers for storage facilities	Logistics Coordinator, MOH/NMCP and DHO
	Double-padlocking and guarding of storage facilities	Supervisor, Sub-County government
	Supervision of spray operators	Supervisors
	Potential development and implementation of environmental monitoring plan	RTI, unknown
	Development and implementation of environmental reporting system	RTI, Program Manager, Supervisors
Storehouse fire, inhalation of toxic fumes from insecticide fire	Renovation of central storage facility	Logistics Coordinator, MOH/NMCP and DHO
	Purchase and renovation of cargo containers for storage facilities	Logistics Coordinator, MOH/NMCP and DHO
	Procurement and distribution of emergency equipment to insecticide storage facilities	Logistics Coordinator, MOH/NMCP and DHO
	Training of storekeepers	RTI and Supervisors
	Development and implementation of environmental reporting system	RTI, Program Manager, Supervisors
Accidents and spillage during transport and storage, leading to human and environmental exposure	Training of drivers for long-distance transport of insecticide and short-distance transport during the campaign period	n/a
	Renovation of central storage facility	Logistics Coordinator, MOH/NMCP and DHO
	Purchase and renovation of cargo containers for storage facilities	Logistics Coordinator, MOH/NMCP and DHO
	Emergency equipment located in storage facilities	Logistics Coordinator, MOH/NMCP and DHO
	Storekeeper training	
	Training of health workers in insecticide poisoning treatment	

	Procurement and distribution of treatment medicines for insecticide exposure	MOH and DHO
	Development and implementation of environmental reporting system	RTI, Program Manager, Supervisors
Flooding of storehouse, leading to environmental contamination	Storage facility sites located on high ground, outside of floodplain	Logistics Coordinator, MOH/NMCP and DHO
Insecticide Quality and Resistance		
Decreased effectiveness of insecticide, lessening impact on malaria incidence	Selection of insecticide to minimize resistance and maximize residuality on surfaces sprayed	MOH
	Lab-testing of insecticide to ensure quality control	National Drug Authority, Logistics Coordinator
	Entomological monitoring of resistance	MOH/NMCP, MOH/DVBD, DHO,CDC, WHO Uganda Office, RTI Program Manager
	IEC Campaign, citing importance of not plastering or painting walls after the home has been sprayed	DHO and Subcontractor
	Data recording on agricultural insecticides for the purpose of knowing how they may contribute to resistance	Supervisors, Team Leaders
	Proper insecticide storage by renovation of storage facilities	Logistics Coordinator, MOH/NMCP and DHO
	Training of spray operators in proper application for specific wall types (uniform spray speed, constant and accurate spray distance, etc).	RTI & Supervisors
	Procurement and use of sprayers manufactured according to WHO specifications	RTI and MOH
	Daily sprayer maintenance	Supervisors
	Development and implementation of environmental reporting system	RTI, Program Manager, Supervisors
Future Activities		
Indirect support of malaria vector control operations that have not undergone environmental review through procurement of sprayers and storage facilities	Importance of an environmental assessment for any pesticides used in IRS will be discussed with MOH and NEMA staff-- online resource for conducting assessments will be provided (http://www.encapafrica.org/)	Program Manager and USAID Environmental Staff
Adaptive Management (potentially reducing pesticide use for malaria vector control)	Development of a strong malaria surveillance system to target IRS interventions, reducing pesticide use	USAID, MOH, HIMAL, DHO
	Pursuit of an integrated strategy involving environmental management and larviciding	MOH

	Development of protocol/implementation of measures to mitigate mosquito resistance to insecticides-- pesticide rotation or mosaicing.	MOH
	Submission of environmental reporting to RTI and USAID Mission Environmental Officer	Program Manager

BACKGROUND AND PURPOSE

The planned IRS program in Kabale District, Uganda, is associated with the U.S. President's Initiative on Malaria in Africa, which was announced 30 June, 2005, seeks to reduce malaria mortality by 50% in up to 15 countries (total population: 175 million) in sub-Saharan Africa by 2010. This 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 (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 insecticide-treated bed nets (ITNs); and
- indoor residual spraying (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 Initiative will support and complement efforts of the Global Fund, the World Bank, and other members of the Roll Back Malaria Partnership. The Initiative will include detailed reporting on inputs, outputs, and results. Angola, Tanzania, and Uganda are the first three countries selected for this Initiative.

Need for Action and the Preferred Alternative

Malaria is endemic in 95 percent of Uganda, with the remaining 5 percent of the country subject to low, unstable transmission and possible epidemics, mainly in the highland areas (WHO/Malaria Consortium/UNICEF 2003). It is estimated that 93 percent of the total population are at risk from malaria. Although all four species of the malaria parasite exist in Uganda, *Plasmodium falciparum* is responsible for over 95 percent of cases. This parasite has shown increasing resistance to both chloroquine (CQ) and sulphadoxine/pyrimethamine (SP) when used separately as monotherapy and more recently as a combination.

Malaria constitutes the majority of the disease burden in Uganda, causing 39 percent of outpatient attendances and 35 percent of inpatient admissions (WHO/UNICEF Malaria Report 2003). In recent years, clinically diagnosed malaria cases reported in the Health Management Information System (HMIS) have risen, increasing from 5 million cases in 1997 to 16.5 million cases in 2003. The two major reasons for this increase are thought to be (1) the abolition of user fees in the public sector with increased utilization of health facilities and (2) increased treatment failures as a result of drug resistance. Since it is known from various surveys that approximately 60 to 80 percent of fever cases are treated in the informal and private sector, these figures translate into 65 million fever

cases in 2003 treated as malaria. The estimated case fatality rate in 2001 was 4.05 percent of in-patient cases (MOH Survey 2001). Current estimated annual numbers of deaths from malaria range from 70,000 to 100,000. Prevalence rates for malaria parasitaemia (asymptomatic) range between 50 percent and 80 percent in young children, 20 percent and 50 percent in older children and generally below 30 percent in adults.

Approximately 50 percent of Uganda experiences very high transmission levels, above 50 infective bites per person per year with maximum of 1,000 infective bites (holoendemic). In this transmission scenario, children bear the brunt of the disease, but as they grow into adulthood, this level of exposure results in acquired immunity against severe effects of malaria. 30 percent of the country experiences medium to high transmission level (10-50 bite per person), 15 percent low transmission (1-10 bites per person), and the remaining 5 percent has low or unstable transmission. Malaria epidemics tend to occur in areas of unstable transmission. People living in these areas have little immunity against the disease because it requires constant exposure to maintain. Therefore the potential for severe disease is much higher in these areas, and during an epidemic the case fatality rate can be as high as 20%. The MOH wants to target areas with unstable transmission for IRS, and chose Kabale District as the location to pilot this intervention. The primary goal of IRS operations in this area is to prevent malaria epidemics, which have plagued Kabale District since 1998.

The preferred alternative, an IRS Program using ICON™ WP, serves to interrupt transmission of malaria from adult female *Anopheles* mosquitoes to humans. A female *Anopheles* mosquito can transmit malaria when taking a blood meal from a human host. Female mosquitoes of this species typically bite after dark, when humans stay inside their homes. After the mosquito bites its human host and takes a blood meal, it rests on an indoor wall of the home. If the walls of the home have been sprayed with pesticide through IRS, the mosquito will absorb the pesticide through its exoskeleton and die. IRS thus prevents the mosquito from both transmitting malaria to another human host and increasing the mosquito population by laying its eggs.

Malaria is the most prevalent disease in Kabale District. It is estimated that 93 percent of the total population in the District are at risk from malaria. The disease is unstable, with great potential for epidemics due to swamp cultivation of Irish potatoes, brick making, hoof prints and flooding. Across the world, it is estimated that a single episode of malaria costs the equivalent of ten working days. Although all four species of the malaria parasite exist in Kabale, *Plasmodium falciparum*, the most dangerous form, is responsible for over 95 percent of cases.

Balancing the known health and economic risks of malaria with the health and environmental risks of indoor residual spraying, the preferred alternative is to spray with ICON™ WP. Box 1 below shows the rationale for this decision.

Box 1. Alternatives Considered and Not Considered.

Alternatives Considered	
IRS Program using ICON™ WP	USAID support would include an IRS program for malaria epidemic prevention in Kabale District with the following components:

	• Purchase of insecticide (ICON™ WP 10% lambda-cyhalothrin), spraying equipment (Hudson X-Pert® sprayers), and adequate amounts of personal protective clothing and equipment for spray operators and wash persons; • Financial support for trainers, spray teams, and transport; • Financial support for storage facility construction and renovation; • Technical advisors to plan the program, train field staff, and supervise field operations; • Analysis to identify epidemic risk-prone parishes in Kabale; • Health education to raise public awareness and promote cooperation; and • Additional human health and environmental safety components.
Alternatives Not Considered	
IRS Program using ICON CS™	ICON CS™ is not yet registered in Uganda, trials on its efficacy are not complete, and ICON CS will not be available by the beginning of spray operations.
IRS Program using Organophosphates, Carbamates, or other Pyrethroids.	Lambda-cyhalothrin is preferred by the MOH, based on its prior experience with the pesticide. Recent field tests (2005) in Kabale District demonstrated a low level of resistance to deltamethrin, lambda-cyhalothrin and permethrin in anopheline mosquitoes. MOH policy allows the continued use of an insecticide so long as resistance does not approach 25%. Lambda-cyhalothrin should be effective in Kabale District when applied at the correct rate. The MOH prefers not to use pyrethroids other than lambda-cyhalothrin, organophosphates, or carbamates for IRS. Pyrethroids, including lambda-cyhalothrin, are generally less toxic to humans than organophosphates or carbamates.
IRS Program using DDT	Uganda has not yet completed the in-country environmental processes necessary to approve DDT use for public health. Additionally, USAID support for DDT use requires an environmental assessment that must be conducted in conjunction with in-country environmental processes.

ITN Program	The MOH currently supports ITN use in Kabale District, and NGOs such as World Vision and the Red Cross are currently providing support in this area. ITNs are also available on the local market. If USAID decides to sponsor an ITN Program in Kabale District, that action is covered in an existing ITN PERSUAP tiering off from the IVM PEA (USAID 2002).
Larviciding	Larviciding is not a strategy currently supported by the MOH. Larviciding could prove a useful long-term strategy for malaria control in Kabale. IRS, however, is an intervention best-suited for short-term prevention of epidemics, the current focus of the MOH.
Environmental Management	Environmental Management is not a strategy currently supported by the MOH. Environmental management could prove a useful long-term strategy for malaria control in Kabale. IRS, however, is an intervention best-suited for short-term prevention of epidemics, the current focus of the MOH.

Human Health and Environmental Effects of Preferred Alternative

As a consequence of implementing the Preferred Alternative, approximately 500,000 people in Kabale District will be covered by this vector control program. 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 incidence of malaria-related childhood anemia, complications, organ failure, and death. Few to no adverse human health or environmental effects are anticipated as result of occupational, residential, and/or environmental exposure to lambda-cyhalothrin due to mitigation efforts. Effects from occupational exposure could include temporary skin and eye irritation, although personal protective equipment should minimize such irritation. It is possible that the impacts of residential exposure could include effects on the neurodevelopment of unborn fetuses, but further research is necessary to test this hypothesis (Berkowitz, et al. 2003). Lambda-cyhalothrin is highly toxic to many fish and aquatic invertebrate species, as well as bees. Improper use or disposal of lambda-cyhalothrin could result in the death of aquatic species in Kabale's sensitive natural habitats, or adversely impact natural beehives or beekeeping operations. Further information on the impacts of lambda-cyhalothrin and proposed mitigation for those impacts is discussed in the *Pesticide Procedures* section.

AFFECTED ENVIRONMENT

The entirety of Kabale District is targeted for IRS using ICON™ WP. Within Kabale District exist multiple administrative levels which will contribute to the planning and implementation of the IRS Program, as illustrated in Table 2. These administrative entities will often be referenced in the remainder of the document.

Table 2. Administrative Divisions of Kabale District.

Administrative Level	Number
District	1
County	4
Sub Health District	7
Sub County	20
Parish	120
Village	3197

Approximately 500,000 people will be affected by the IRS Program. Table 3 breaks down this population by Health Sub-District and Sub-County. Annex 2 shows the location of Kabale District in Uganda, and Annex 3 displays a map of parishes within the District.

Table 3. Population Affected by IRS Program.

County	Health Sub-District	Sub-County	Population (2006 Estimate)
Kabale Municipality	Kabale Municipality	Central	15952
		Northern	11792
		Southern	16362
Ndorwa	Ndorwa East	Buhara	26124
		Kaharo	19512
		Kyanamira	20781
		Maziba	17718
	Ndorwa West	Kamuganguzi	25900
		Kitumba	18801
		Rubaya	27438
		Butanda	15369
Rubanda	Rubanda West	Bufundi	24829
		Ikumba	34862
		Muko	41385
	Rubanda East	Bubare	46132
		Hamurwa	28725
Rukiga	Rukiga South	Bukinda	20921
		Kamwesi	27207
	Rukiga North	Kashambya	25515
		Rwamucucu	26015
District Total			**491340**

ENVIRONMENTAL CONSEQUENCES

Unavoidable Adverse Effects

The risk of vehicle accidents and consequent insecticide spillage is always present. Such spillage could expose both humans and aquatic environments to lambda-cyhalothrin. 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, as open-burning of lambda-cyhalothrin creates nitrogen oxides, hydrogen chloride, and hydrogen fluoride (WHO 1997).

Irreversible or irretrievable commitments of resources

All financial costs of this program are irretrievable. It is important to note that, after implementation of this proposal, the Uganda MOH would acquire new insecticide storage facilities and sprayers 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. These risks will be discussed during training of MOH staff.

Environmental impacts of the proposed action

The primary environmental risks include mortality of bees (both in the natural environment and in beekeeping operations) and the mortality of freshwater fish and invertebrates. Impacts on bees, freshwater fish and invertebrates are severe and acute, but transitory. (The number of potentially affected individuals in a population cannot be predicted for several reasons: because little is known about the number and location of populations of bee, freshwater and fish and invertebrate species in the Kabale, and the extent of impact depends on the extent of contamination). The training and supervision of spray personnel should adequately address this risk; however, environmental monitoring will be carried out to ensure that lambda-cyhalothrin used in IRS does not impact sensitive areas.

Direct and indirect effects and their significance

Direct Effects

USAID will directly support the use of lambda-cyhalothrin for malaria vector control in Kabale District, Uganda. This support will likely have few adverse human health and environmental effects, while providing protection against epidemic malaria to approximately 500,000 people. This protection will reduce the incidence of adult morbidity, miscarriages, low birth-weight, and adverse effects on fetal neurodevelopment. It will also reduce incidence of malaria-related childhood anemia, complications, organ failure, and death.

Indirect Effects

Through this action, USAID will be providing the Uganda MOH with insecticide storage facilities, sprayers, and transport vehicles. Upon completion of this 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. It is probable that, in the future, capital conveyed to the MOH would be used for application of DDT for malaria vector control.

Pesticide Procedures: Review of Elements [22 CFR 216.3(b)(1)]

A. The USEPA registration status of the requested pesticide

ICON™ WP is registered for public health use in Uganda (see third bullet in *basis for selection of the requested pesticide*). Both products contain the same percentage of the active ingredient, lambda-cyhalothrin.

Insecticide:	Lambda-cyhalothrin
CAS Registration Number:	91465-08-6
Formulation:	Wettable Powder (10% active ingredient)
Trade Name:	ICON™
US Products Registered for "Similar" Uses:	10182-96

B. The basis for selection of the requested pesticide

Lambda-cyhalothrin was selected for the following reasons:

- The MOH chose to use ICON™ WP based on prior experience with the formulation. However, there has been no entomological evaluation of ICON™ WP in Uganda, only anecdotal evidence of its impact on malaria transmission.
- In Uganda, pyrethroid resistance ranges from 3 percent to 30 percent, depending on the district. In Kabale District, *Anopheles gambiae s.l.* was detected as having 14 percent resistance. The MOH recommends that public health insecticides be replaced when resistance reaches 25 percent.
- ICON™ WP is currently registered in Uganda for use with IRS, per WHO recommendation.
- According to the US Environmental Protection Agency, lambda-cyhalothrin is a category II pesticide. It is low to moderately toxic, not carcinogenic, readily breaks down in the environment, and does not bio-accumulate. It is registered for use on the following residential non-food sites: general indoor/outdoor pest control (crack/crevice/spot), termiticide, ornamental plants and lawns around homes, parks, recreation areas and athletic fields, and golf course turf (USEPA 1997).

C. The extent to which the proposed pesticide use is part of an integrated vector management program

The NMCP promotes the use of ITNs and IRS for malaria vector control. The main focus of the NMCP's ITN strategy is:

- Creation of demand for nets and insecticides
- Ensuring availability of affordable quality nets and insecticides in urban and rural retail outlets
- Provision of subsidized ITNs to vulnerable groups
- Promoting correct use of ITNs and maintenance of their effectiveness

The NMCP Malaria Control Strategic Plan 2001/2-2004/5 states that "IRS using acceptable insecticides will be instituted at a recommended frequency to halt transmission in epidemic prone areas. IRS will also be encouraged where use of ITNs is difficult (e.g. boarding schools, barraks, prison cells, and in-patient health facilities) regardless of level of endemicity" (pages 14-15).

Larviciding is rarely used for malaria vector control, and has not been adopted as an IVM strategy by the MOH. The MOH also has not adopted environmental management as a malaria vector control strategy,

although this strategy has been used on a trial basis in recent years. Aside from ITNs and IRS, the Malaria Control Strategic Plan 2001/2-2004/5 states that "other vector control approaches will be encouraged where appropriate" (page 15).

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 the treated surfaces upon which the 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 IRS programs 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 and is typically implemented by teams of spray operators who spray houses in at-risk localities prior to the rainy season, as 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. A water-soluble insecticide is added to the sprayer containing a pre-measured amount of water, the prayer is pressurized, and the material is then carefully applied to the interior walls of targeted homes and structures. After the day's spraying is complete, spray operators must clean the sprayer following the manufacturer's recommendations to ensure their proper operation and calibration. Spray operators will wash themselves and their protective wear (apart from that which will be washed by a commercial laundry or wash person) after each day's operations.

The spray equipment used for IRS will be Hudson X-Pert® sprayers. These sprayers are manufacturered following WHO specifications for compression sprayers for IRS operations. Spray operators will receive intensive training on the use, operation, calibration and repair of the sprayer and practical exercises during a 14 day period prior to the beginning of the spraying campaign. This training will be conducted in accordance with WHO's "Manual for Indoor Residual Spraying" (WHO 2002) and H.D. Hudson Manufacturing Company's "Indoor Residual Spray Team Training: A Cascade Training Guide and Checklist." In this way, spray operators will be prepared to conduct appropriate application of the insecticide.

Each spray team will consist of six or seven spray operators. Within each district, community members will select the spray operators that will spray their own communities. The District Health Office will organize sensitization meetings with sub-county and parish officials so they are aware of the IRS campaign, and are informed on the criteria by which spray operators should be chosen from the community. The spray teams trained for this Program will likely include women. Pregnancy tests will be given to all selected women to ensure that pregnant women are not placed on the spray team. Each spray operator will be provided with the following safety equipment, in accordance with WHO specifications:

- 3 Khaki Overalls
- Broad-rimmed Hat
- Face shield

- Rubber Gloves
- Rubber Boots

Each spray team will be monitored by a team leader who will use GIS technology (provided by USAID) to record the following data:

- Location Details
  - Sub-County
  - Parish
  - Latitude/Longitude
- Family Data
  - Family name
  - Family size
  - Ages
  - Sex
  - Occupation
  - Education Level
  - Pregnancy Status
- House Data
  - House Construction Type (walls and roof materials)
  - House Size
  - Number of Rooms
- Malaria History
  - Number of Episodes Last Month (by family member)
  - Number of Episodes Last Year (by family member)
- Malaria Control Data
  - Number Bed Nets
    - Size, color, shape, condition
  - Intermittent Presumptive Treatment
  - Environmental Management Activities
  - Distance from Health Facility
  - Health-seeking behavior of family members
- Resistance Data
  - Name of any pesticides used in farming
  - Amount of insecticide used
  - Timeframe when the insecticide is used
  - Duration of the "spray season"

Supervisors will be selected within each parish, and will supervise two spray teams. Supervisors will travel between spray teams and will observe spray operators and team leaders in the preparation, spray technique, and sprayer and PPE cleanup during the IRS campaign, as well as compile all data collected by their respective teams. Supervisors will receive training according to WHO and H.D. Hudson Manufacturing Company's best professional practices, and will also receive additional training on personnel management, environmental aspects, entomological monitoring, geographical reconnaissance, and data recording and analysis. After each day's spray activities, supervisors will collect sachet packing material to track the amount of insecticide used, and ensure that spray operators practice proper personal hygiene to avoid prolonged insecticide exposure.

The Program Manager, select supervisors, and USAID staff (as appropriate) will supervise and report on safety and environmental procedures during the spray campaign, ensuring that best professional practices are implemented.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use and measures available to minimize such hazards

For acute and long-term toxicological hazards, see the RTI International *Toxicological Profile for Lambda-cyhalothrin*, found in Annex 4.

The steps to mitigate, to the fullest extent possible, occupational exposure to lambda-cyhalothrin are mentioned in the preceding section and described fully in the WHO's "Manual for Indoor Residual Spraying" (WHO 2002) and H.D. Hudson Manufacturing Company's "Indoor Residual Spray Team Training: A Cascade Training Guide and Checklist." However, as in all IRS operations, the risk of residential exposure is also present. The Kabale District Health Educator and Assistant Health Educators in the Health Sub-Districts will work with the local communities and non-governmental organizations to carry out an IEC campaign to sensitize Kabale residents to IRS activities, in accordance with WHO and H.D. Hudson Manufacturing Company's guidelines. The Kabale District Health Educator identified communication through radio, schools, and the religious community as the most effective means of sensitizing the public. IRS Program team leaders will also instruct residents on best practices prior to spraying, in particular:

- 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, if possible
- Stay outside the home during spraying and for one hour after spraying
- Move and keep all animals outside the home during spraying, and for one hour after spraying
- 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.

The MOH and the Kabale District Health Office were keenly interested in having pyrethroid poisoning training for Kabale Regional Hospital physicians and Health Center III (HCIII) workers in the District. USAID will provide such training, which will be held at Kabale Regional Hospital. During this training, more detailed descriptions of exposure symptoms and guidelines for treatment (see Annex 5 for an example) will be given to trained health workers prior to the start of operations. HCIII workers were chosen to receive this training because each sub-county contains an HCIII.

Six medicines are required to treat symptoms of lambda-cyhalothrin exposure:

- Topical vitamin E (tocopherol acetate) for dermal exposure
- Topical anaesthetic for ocular exposure
- Flourescein stain for ocular exposure
- Atropine for ingestion exposure
- Diazepam for ingestion exposure
- Phenytoin for ingestion exposure

Kabale Regional Hospital has access to all but Topical vitamin E and Topical anaesthetic. USAID will work with the MOH to make sure all six medicines are provided to Kabale Regional Hospital and HCIII facilities.

Prior to long-distance transport of the insecticide from the customs warehouse/central storage facility to the 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, implications of the insecticide getting into the public
- 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

- Training provided to spray operators (with the exception of sprayer operation and spray practice)
- Handling an accident or emergency (according to FAO standards)
- Handling vehicle contamination (see below)

Because vehicles will be rented for the 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 will be provided with gloves to wear for cleaning the vehicle. All cloths used in wiping down the interior and bed of the vehicle should be washed with spray operator overalls.

F. The effectiveness of the requested pesticide for the proposed use

The effectiveness of pesticides chosen is a factor of vector resistance and residual persistence. In Uganda, pyrethroid resistance ranges from 3 percent to 30 percent, depending on the district. In Kabale District, *Anopheles gambiae s.l.* was detected as having 14 percent resistance. The MOH recommends that public health insecticides be replaced when resistance reaches 25 percent. Pyrethroids are commonly used in Kabale's agricultural sector, but the extent of their use and potential impact on *Anopheles* resistance is unknown. Monitoring activities conducted by vector control specialists from the MOH (entomologists) will determine the effectiveness and residuality of ICON™ WP in these indoor ecosystems.

G. Compatibility of the proposed pesticide with target and nontarget ecosystems

The application of lambda-cyhalothrin for IRS should be fully compatible with non-target ecosystems, provided that training and supervision are adequate. One key concern is the contamination of aquatic ecosystems from disposal of rinse-water and washing of overalls, which is unlikely to occur given the intense training conducted prior to the campaign, the daily supervision that will occur during the campaign, and spot-checks conducted (as part of mitigation monitoring) to ensure implementation of mitigation activities. Another concern is the potential exposure of bees to lambda-cyhalothrin. Beekeeping is common around protected areas and forests, and care should be taken that such practices are unaffected by indoor spraying. According to the International Programme on Chemical Safety (IPCS), "With recommended techniques and rates of application, it is unlikely that cyhalothrin and lambda-cyhalothrin and their degradation products will attain levels of adverse environmental significance" (1990).

H. The conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils

Kabale District experiences a year-round tropical climate with temperatures that rarely go below 15º C or above 30º C. Kabale has two main rainy seasons: the heavy rain occurs from March to May and light rains occur from September to November. The main dry season occurs from June to August, and another dry season occurs from December to February.

The mean annual rainfall in the District is 1,092 mm. The annual maximum temperature is 24.10º C and annual minimum is 11.60º C. According to the Kabale Meteorological Department, the relative humidity throughout the year ranges between 90 and 100 percent in the morning and decreases to between 42 and 75 percent in the afternoon. Annex 10 shows the soil types of Kabale and surrounding districts.

Kabale District is an extremely important area environmentally. It serves as the gateway to Bwindi Impenetrable National Park, one of the most biologically diverse areas in Africa. The District also contains portions of two other protected areas, Eshuya and Mafuga Forests. Additionally, Kabale District is home to environmentally sensitive wetland ecosystems, many of which have been converted to cultivation areas. Annex 7 illustrates the location of these protected and sensitive areas in Kabale District.

In 1994, Bwindi Impenetrable National Park became a World Heritage Site. Box 2 contains excerpts from the Protected Areas Programme of UNEP World Conservation Monitoring Centre which reveal the importance of Bwindi Impenetrable National Park.

Box 2. Bwindi Impenetrable National Park.

Bwindi is characterised by steep hills and narrow valleys, with a general incline from the north and western areas (below 1,750m), to the south-western corner (above 2,250m). Together with some remnant lowland forest outside the boundary, the park constitutes an important water catchment area serving surrounding agricultural land. Three major tributaries of the Ishasha River drain into Lake Edward to the north, and the Ndego, Kanyamwabo and Shongi Rivers flow southwards towards Lake Mutanda. In geological terms, the area is associated with upwarping of the western rift valley and its underlying rocks are phyllites and shales, with some quartz, quartzite and granite outcrops of the Karagwe-Ankolean System (Howard, 1991). The soils are mainly humic red loams, moderately to highly acidic and deficient in bases (Howard, 1991). Due to the steepness of slopes, the soils are very susceptible to erosion in areas where trees are cleared.

Bwindi's climate is tropical with two rainfall peaks from March to May, and September to November. The annual mean temperature range is 7-15° C minimum to 20-27° C maximum; annual precipitation lies in the range 1,130-2,390mm (Howard, 1991) (UNP, 1993).

Bwindi is one of the few large expanses of forest in East Africa where lowland and montane vegetation communities meet. Combined with its probable role as a Pleistocene refuge, this situation has led to an extremely high biodiversity. Current evidence indicates that Bwindi is the most diverse forest in East Africa for tree species (more than 200 species) and ferns (more than 104 species), as well as other taxa. In recognition, Bwindi was selected by IUCN's Plant Programme as one of the 29 forests in Africa most important for conserving plant diversity. The forest gets the name 'impenetrable' from the dense cover of herbs, vines and shrubs inhabiting the valley bottoms. Following Langdale-Brown (1964), the area is broadly classified as medium altitude moist evergreen forest, and high altitude forest. Approximately 40% of the forest is rich to medium-rich mixed forest, including key species such as *Prunus africana*, nationally threatened *Newtonia buchananii* (V), *Symphonia globulifera*, *Chrysophyllum* spp., *Podocarpus* spp., and *Strombosia scheffleri*. There are three (presumably climax) communities which tend to single-species dominance, the dominant depending on altitude. In the low-lying areas around 1,500m, *Parinari exelsa* is the dominant (about 10% of the park); around 2,000m it is *Newtonia buchananii* (about 11% of the park); and at around 2,200m, *Chrysophyllum gorungosanum* dominates (about 8% of the park). Almost 30% of the park is occupied by low stature communities, classified as poor, hill and colonising types. There are also small areas of swamp and grassland. Bamboo forest is restricted to less than 100ha. The trees of Bwindi are not particularly well known, and thus the current list may be far from complete. Nevertheless, the list of 200 species (47% of the country's total) includes 10 species not found elsewhere: *Croton bukobensis*, *Strombosiopsis tetrandra*, *Brazzeia longipedicellata, Grewia milbraedii*, *Maesobotrya purseglovei*, *Balthasaria schliebenii*, *Xylopia staudtii, Allanblackia kimbiliensis*, *Memecylon* spp., and *Guarea mayombensis* (Howard, 1991) (Kakuru, in prep.). A further 16 species have only a very restricted distribution in south-west Uganda, and one internationally threatened species, namely *Lovoa swynnertonii* (R) (Howard, 1991).

Bwindi is believed to hold the richest faunal community in East Africa, including over 214 species of *forest* bird (336 species in total), 120 species of mammals (including 7 species of diurnal primate), and 202 species of butterfly (84% of the country's total). Highly significant is the presence of over one third of the world's population of mountain gorillas *Gorilla gorilla berengei* (about 300 out of 650) (CR) which live in some 23 family units (von Zeipel, 1996). A total of 12 species of bird, one primate and 3 butterflies occur only in Bwindi (and in some cases neighbouring highland forests of south-west Kigezi) within their Ugandan range. The birds are Fraser's eagle owl *Bubo poensis*, dwarf honeyguide *Indicator pumilio* (LR), African green broadbill *Pseudocalyptomena graueri* (VU), white-bellied robin chat *Cossypher roberti* , Kivu ground thrush *Zoothera tanganjicae* (LR), Grauer's rush warbler *Bradypterus graueri*, Grauer's warbler *Graueria vittata*, short-tailed warbler *Hemitasia neumanni*, yellow-eyed black flycatcher *Melaenornis ardesiaca*, Chaplin's flycatcher *Muscicapa*

lendu (VU), montane double-collared sunbird *Nectarinia ludovicenis* and dusky twinspot *Clytospiza cinereoinacea*; the primate is the mountain gorilla; and the butterflies are cream-banded swallowtail *Papilio leucotaenia* (VU), *Graphium gudenusi* and *Charaxes fournierae*. Bwindi is an important locality for the conservation of Afromontane fauna, in particular those endemic to the mountains of the western rift valley. At least 70 of the 78 montane forest bird species occurring in the Albertine Rift region are found in the forest, including 22 of the 27 endemic species. In the case of butterflies, 8 Albertine Rift endemics are known to occur in the forest, which may be the most important in Africa for the conservation of montane butterflies (Butynski, 1993). Globally threatened species include eastern chimpanzee *Pan troglodytes schweinfurthi* (EN), l'hoests monkey *Cercopithecus l'hoesti* (LR), African elephant *Loxodonta africana* (EN) numbering an estimated 30 individuals (Said *et al.*, 1995) and African giant swallowtail *Papilio antimachus* (DD) (Howard, 1991). Buffalo were poached to extinction in the late 1960s, and leopard too more recently.

Bwindi is undoubtedly the most important area in Uganda for species conservation due to its exceptional species diversity, including many Albertine Rift endemics and 9 globally threatened species. Bwindi is also believed to hold the richest faunal community in East Africa, due in part to its provision of an extensive lowland-montane forest continuum. Further, Bwindi is internationally important as the habitat of more than one third of the world's population of mountain gorillas.

For References and Acronyms, see the World Conservation Monitoring Centre website http://www.wcmc.org.uk/protected_areas/data/wh/bwindi.html, accessed November 12, 2005.

The Echuya forest is a bamboo forest that is also important for biodiversity (see Annex 9). The East Africa Natural History Society (EANHS) in Uganda (also known as NatureUganda) conducts environmental monitoring activities in the Echuya Forest Reserve, as well as other sensitive areas in Uganda. Box 3 provides text written by the society that illustrates the importance of Echuya Forest Reserve.

Box 3. Echuya Forest Reserve

Echuya Forest Reserve includes a permanent high altitude swamp (Muchuya) at 2,300 m, about 7 km long by up to 750 m wide, in a narrow valley surrounded by steep forested hillsides. The swamp vegetation is dominated by sedges (*Carex spp*) and includes tussock vegetation and giant lobelias. The swamp drains northwest into the Murindi River. Currently, there are no conservation measures for the swamp but the surrounding forests are protected in the 3400 ha Echuya Forest Reserve, which completely surrounds Muchuya Swamp. Echuya is dominated by Hagenia-Rapanea moist montane forest and Arundinaria montane bamboo (Davenport et al 1996d). Echuya may not be as diverse as other Ugandan forests (using an index of species per unit area, as recorded by the Forest Department biodiversity inventory). However, in terms of conservation value of the species represented (based on the world-wide distributions and occurrence in Uganda forests), Echuya is ranked among the top 10% of sites visited by the Forest Biodiversity Inventory Team (Forestry Department, 2000).

Globally-threatened bird species

Grauer's Swamp Warbler
Vulnerable
Recorded by Wetlands biodiversity Inventory Team in 1994 and 1995. The Forest Biodiversity

Inventory also reported the bird in the swamp in sizeable populations. See also Scott et al (1994) and Davenport et al (1996d).

Dwarf Honeyguide
Near-threatened
Globally near-threatened and restricted range species (Rossouw and Sacchi, 1998).

Kivu Ground Thrush
Near-threatened
Was recorded in 1997 (Marks and Gnoske in press)

Echuya Forest Reserve, including the Muchuya swamp, has a total of 100 bird species recorded. Of these, there are 13 Albertine Rift EBA species and high proportions of other species that are highland forest dependent (Davenport and Howard, 1996, Marks and Gnoske, in press). In view of its size, the swamp is likely to support a larger population of Grauer's Swamp Warbler *Bradypterus graueri* than the nearby Mubwindi swamp, one of only a few known localities for this species in Uganda. There are 44 of 86 highland biome species in the reserve, which include such rare species as Dwarf Honeyguide, Handsome Francolin, Rwenzori Batis, Strange Weaver and Dusky Crimson-wing.

Other threatened/endemic wildlife

The flora in the swamp is characteristic of highland vegetation, and this makes it an interesting wetland at intermediate elevation. 124 species of plants are known in Echuya, 19 small mammal species including four Albertine endemics, namely *Lophuromys woosnami*, *Dasymys montanus*, *Myosorex blarina*, and *Sylvisorex lunaris*. A rare relict species, *Delanymys brooksi*, which is restricted to montane swamps, is also known to occur. However, the conservation status of this species has not been ascertained although it is known to be restricted to a small area in the Albertine Rift area and possibly occurring at low population density (Kingdon 1971-1974).

Conservation issues

Muchuya swamp is surrounded by the Echuya Forest Reserve but it is not itself part of the protected area. A concession was given to a private developer and there was development of a dairy farm on the edges of the swamp in the reserve. A drainage system had been created right along the valley to drain the swamp and it could have been completely drained to create more space for cattle farming. This would have endangered *Bradypterus graueri* and other restricted range species in this swamp. However, the Forestry Department cancelled the concession and the cattle have been moved out of the reserve. Densely populated agricultural land surrounds the Forest Reserve although agricultural encroachment appears not to be significant. However, the reserve is used as the main source of bamboo for building and crafts by the local communities. It is recommended that Muchuya swamp be given a strong protection status because of the important and rare habitat supporting internationally important species.

Endangered wetlands are also present in the valleys of Kabale District. These wetlands contain the indigenous mudfish, which is over-exploited and used for fish-bait. Additionally, these wetlands provide habitat for the endangered Sitatunga, an "amphibious antelope" that is often hunted for its meat. The wetlands are also vitally important for endemic papyrus birds, such as warblers, as well as migratory birds. Annex 8 illustrates the importance of these wetlands to bird populations. Out of Kabale District's total area of 1,827 square kilometers, only 79.4 square kilometers are wetland areas.

Mafuga Forest, another protected area, is a timber harvest plantation managed by the Forest Authority.

The primary environmental risks include negative impacts on bee hives and contamination of aquatic ecosystems, which could adversely affect the sensitive wetland ecosystems in Kabale District. No spraying will be conducted inside the boundaries of protected areas/sensitive ecosystems themselves, and no outdoor spraying will be conducted. Additionally, every effort will be made to mitigate these potential environmental impacts, including:

- 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 Program.
- Supervision of persons hired to wash protective outerwear.
- Re-use of spray operators' wash-water and protective wear wash-water in sprayers when water contents will not damage sprayers.
- Hydrolysis and disposal of wash-water in latrines. This would occur when wash-water contents could damage sprayers (e.g. when too much particulate matter is in the wash-water).
- Decontamination of any contaminated packaging prior to disposal.
- Environmental reporting.
- Environmental monitoring.

I. The availability and effectiveness of other pesticides or non-chemical control methods

Other Pesticides. Currently, Uganda has no formal registration system for public health pesticides. The National Drug Authority (NDA) acts as the gatekeeper for public health pesticides, requiring evidence of safety and efficacy of any public health pesticides imported. If a public health pesticide is internationally recognized (e.g. recommended by the WHO), then import is essentially guaranteed. This means that all twelve WHO-recommended chemicals for IRS could potentially be used for IRS interventions in Uganda. The WHO-recommended chemicals include:

- Alpha-cypermethrin
- Bendiocarb
- Bifenthrin
- Cyfluthrin
- DDT
- Deltamethrin
- Etofenprox
- Fenitrothion
- Malathion
- Pirimiphos-methyl
- Propoxur

Because DDT is included in the Stockholm Convention, approval for its use in malaria control is required through the National Environmental Management Authority (NEMA). (The National Drug Authority approves drugs for human health, and plays a key role in deciding which pesticides should be used for public health uses from that standpoint. NEMA looks at pesticides more broadly, taking into account environmental considerations). Generally, NEMA will not question the use of public health pesticides when those pesticides have not been addressed in an international treaty; however, when spraying is conducted on a large scale, NEMA requests that methods for environmental monitoring be submitted for review.

The effectiveness of alternative IRS pesticides depends highly on vector resistance and house construction materials. Carbamates (Bendiocarb, Propoxur), organophosphates (Malathion, Fenitrothion, Pirimiphos-methyl), and organochlorines (DDT) are more appropriate for traditional mud-walled houses most commonly found in Kabale District. Pyrethroids can be effective, however, if they are formulated specifically for mud-walled houses or if the spray rate is decreased.

Non-Chemical Control Methods. According to the 1997 Kampala Declaration on Sanitation, districts should conduct environmental management activities such as maintaining drains, and educating communities about hygiene and sanitation. Workers that were supposed to have maintained drains were laid off, and some of the work was contracted out. Little progress has been made in environmental management due to a lack of funding.

Additionally, the Public Health Act requires that brick pits be drained. Local and District officials have not pursued brick pit drainage as malaria control strategy. Cultivation practices in Kabale are suspected to be a major contributor to *Anopheles* breeding—in particular, crop furrows can provide ideal breeding sites for *Anopheline* mosquitoes. Table 4 describes the parishes that are pre-disposed to epidemics, based on environmental factors.

Table 4. Epidemic-Prone Areas of Kabale District

County	Sub County	Parish	Epidemic Pre-Disposing Factors
Rukiga	Kamwesi	Kigara	Swamp cultivation e.g. beans, maize, etc. Area prone to flooding.
		Kashekye	Low-lying and prone to flooding—collects all water from surrounding hills.
		Rwenyangye	Swamp cultivation e.g. Irish potatoes and other crops
		Kibanda	Many cattle watering wells. Has biggest number of cattle in District. Area is swampy with many hoof prints.
	Bukinda	Nyakasiru	Extensive brick making, swamp cultivation e.g. Irish potatoes
		Nyabirirema	Swamp cultivation e.g. Irish potatoes and also neighbors Nyaksiru Parish with a lot of brick making.
	Kashabya	Rutegye	Swamp cultivation e.g. Irish potatoes. Area prone to flooding.
		Kitanga	Valley prone to flooding. Some swamp cultivation and fish farming.
		Nyakashebeya	Swamp cultivation especially Irish potatoes. Valley prone to flooding.
	Rwamucucu	Mparo	Swamp cultivation especially Irish potatoes. Valley prone to flooding.
		Noozi	Swamp cultivation especially Irish potatoes and other crops.
		Kitojo	Swamp cultivation especially Irish potatoes and vegetables.
Rubanda	Hamurwa	Hamurwa	Swamp cultivation e.g. Irish potatoes.
		Shebeya	Swamp cultivation especially Irish potatoes.
	Bubaare	Bubaare	Swamp cultivation especially Irish potatoes. Valley prone to flooding.
	Muko	Nyarurambi	Swamp cultivation especially Irish potatoes. Valley

			prone to flooding.
Ndorwa	Maziba	Birambo	Swamp cultivation.
	Kaharo	Kaharo	Valley with a stream which is prone to flooding every time it rains.
	Kainamira	Nyakagyera	Extensive brick making. Some swamp cultivation e.g. Irish potatoes.
	Buhara	Kafunjo	Swamp cultivation especially Irish and sweet potatoes. Valley prone to flooding.
		Katanga	Swamp cultivation especially Irish and sweet potatoes. Valley prone to flooding.
	Kamuganguzi	Mayengo	Valley prone to flooding. Swamp cultivation especially Irish potatoes and vegetables.
		Kisasa	Valley prone to flooding.
		Kyasano	Swamp cultivation especially Irish potatoes and vegetables.
Kabale Municipality	Southern Ward	Bushoro	The District's leading parish in brick making and is prone to flooding.

J. The requesting country's ability to regulate or control the distribution, storage, use and disposal of the requested pesticide

Distribution. Insecticide, PPE, and personnel will be transported from the storage sites to target villages by truck. Trucks used for this activity will be hired locally through Program funds.

Storage. The Kabale District transport yard, located in Kabale Town, contains a spacious storage facility that will be outfitted for IRS insecticide and equipment storage. The facility is in need of renovation, specifically:

1. Replacement of wooden doors with metal doors
2. Installation of an additional door for exiting the facility
3. Roof stabilization/patching holes
4. Replacement of large grates with walls to prevent exposure to rain and entrance of vermin
5. Top and bottom ventilation (with grates/screens to prevent entrance of vermin)
6. Installation of sills and a sump
7. Installation of a partition to separate insecticides from protective equipment
8. Outfitting of small office adjacent to storage facility
9. If necessary, replace current electrical fittings with those that are mineral insulated or armoured cable with flame/dust-proof fittings (necessary for fire prevention)
10. Pallets for insecticide stacking
11. Fire safety/emergency equipment, including
    - a few bags of sawdust and/or sand to absorb leaked or spilled pesticides;
    - a number of empty containers (preferably salvage drums that can contain a whole 200-litre drum) and empty bags to repack heavily damaged or leaking containers;
    - spade and brush;
    - fire extinguisher;
    - protective gear for staff to enable them to deal with emergencies (nitrile rubber or neoprene gloves, rubber boots, overalls, goggles, vapour masks or half-face respirators with organic vapour cartridges)

- water supply from a tap, or a container of water, to wash hands and face if these become contaminated;
- eyewash set.

The transport yard in which the storage facility is located is secure and guarded 24 hours, 7 days per week. All entryways to the storage facility will be double padlocked to deter pilferage. The storekeeper for this facility will be trained on proper storage conditions, record-keeping, and emergency handling of insecticides according to FAO standards (see Annex 11).

In addition to this central storage facility, each sub-county in Kabale District (20 total) will receive two cargo containers for IRS insecticide and equipment storage. These cargo containers will be located at the sub-county offices, where guards are posted 24 hours, 7 days per week. If the proposed location site is flood-prone, then the cargo containers must be relocated at a non-flood-prone site. Each cargo container will be double-padlocked to deter pilferage.

One cargo container will be used for insecticide, sprayer, barrel and tub storage, while the other will serve as a storekeeper office and storage for personal protective equipment. The cargo container used for insecticide storage will be renovated as appropriate:

1. Construction of roof to shade the container and prevent high interior temperatures.
2. Top and bottom ventilation (with grates/screens to prevent entrance of vermin)
3. Installation of sills
4. Installation of a sump (if feasible)
5. Laying of concrete flooring with bunds for the entire container storage site (to prevent environmental contamination from spills)
6. Electricity (electrical fittings should be mineral insulated or armoured cable should be used with flame/dust-proof fittings, as necessary for fire prevention)
7. Pallets for insecticide stacking
8. Fire safety/emergency equipment, including
    - a few bags of sawdust and/or sand to absorb leaked or spilled pesticides;
    - a number of empty containers (preferably salvage drums that can contain a whole 200-litre drum) and empty bags to repack heavily damaged or leaking containers;
    - spade and brush;
    - fire extinguisher;
    - protective gear for staff to enable them to deal with emergencies (nitrile rubber or neoprene gloves, rubber boots, overalls, goggles, vapour masks or half-face respirators with organic vapour cartridges)
    - water supply from a tap, or a container of water, to wash hands and face if these become contaminated;
    - eyewash set.

To every extent possible, these containers will be renovated according to best practices, as reflected in a section of FAO's *Pesticide Storage and Stock Control Manual* in Annex 11. Each store will have the following for dealing with emergencies (per FAO standards):

Disposal. ICON™ WP sachets are water-soluble, and are placed directly into the compression sprayer during operations. As a result, spillage of the insecticide and contamination of packaging material should be minimal during spray operations. Insecticide packaging (boxes, paper/plastic wrappers, etc.) can be shredded, and taken to a power station or cement kiln to be used as fuel. Any contaminated packaging should be triple-rinsed (with rinse-water added to progressive rinse barrels, see next paragraph) prior to shredding and incineration. According to the FAO's *Draft Guidance Document: The Selection of*

Waste Management Options for the Disposal of Obsolete Pesticides and Contaminated Materials:

> *The material from which the containers and packaging are constructed is generally environmentally harmless in itself and is suitable for recycling or disposal within the country. The degree of residual pesticide contamination within the materials is the only issue that may prevent this from occurring.*
>
> *FAO advises the "triple rinsing" of containers after the content has been used. If this has been done, the containers will be perfectly safe for recycling or disposal locally. However, before they are sent for recycling or disposal, they should be mechanically deformed by cutting or crushing to render them unusable for storage or conversion into utensils.*
>
> FAO 2004:60

According to the FAO, plastic containers that have been decontaminated can be recycled and used as materials that are not used as food/water containers or preparation materials (e.g. building materials).

ICON™ WP will be shipped in barrels that will then be used for rinsing sprayers through the "progressive rinse" method, developed by Manuel F. Lluberas for other IRS programs in Africa. With this method, several barrels are placed in a line. The first barrel is full of water, the second empty, the third full of water, and so on. Water from the first barrel is used to rinse the sprayer, and then poured into the empty second barrel. Water from the third barrel is used for a second rinsing of the sprayer, and is then poured into the empty fourth barrel. This continues until the last rinse water is poured into the last barrel. The contaminated rinse water is then used to fill up the sprayers in the next day's spraying. This method virtually eliminates environmental contamination from sprayer rinse-water. All barrels will be inscribed as District Health Office property, and will be labeled with poison stickers to ensure that locals recognize that the containers are not suitable for domestic use. At the end of spraying operations, sprayer rinse water will be stored in the locked storage facilities for use in the following spray season.

Rinse-water from washing khaki coveralls and furniture cloths will be decontaminated through hydrolysis. For decontamination using hydrolysis, use a 1:1 mixture (by volume) of:

- either 5% sodium hydroxide (caustic soda) solution or saturated (7-10%) sodium carbonate (washing soda) solution

and

- a water/oil soluble solvent, such as denatured alcohol, monoethylene glycol, hexylene glycol, or 2-propanol.

Cover the contaminated surface with this hydrolyzing agent and leave it for seven days. The IPCS recommends that, before disposing the resultant waste, it should be analyzed to ensure that the active ingredient has been degraded to a safe level (IPCS 1990). The IRS program will have the rinse water analyzed to determine the level of active ingredient remaining after decontamination, but discontinue such analysis if results remain consistent. The resultant waste will be disposed in pit latrines.

If a commercial laundry is available within Kabale or nearby districts, it will be utilized for daily washing of all spray operators' overalls. Compared to daily hand-washing of overalls by a wash person, the use of a commercial laundry would minimize the risk of occupational and environmental exposure.

Contaminated rinse-water will be collected daily in the event that a commercial laundry is available. The rinse-water from the laundry will be recycled and used in the spray campaign when possible, and otherwise decontaminated, analyzed, and disposed in latrine pits.

If a commercial laundry is not available, a local person (within each sub-county) will be hired in the spray localities to wash and dry the overalls, using washtubs provided through the Program. All tubs used for this purpose will be inscribed as District Health Office property, and will be labeled with poison stickers to ensure that locals recognize that the containers are not suitable for domestic use. The wash-person will be provided with their own protective gear for this activity—chemical aprons, rubber boots, and rubber gloves. Contaminated rinse-water will be recycled and used in the spray campaign when possible, and otherwise decontaminated, analyzed, and disposed in latrine pits.

K. The provisions made for training of users and applicators

Training for supervisors, team leaders, and spray operators will be conducted over a 7 to 14 day period. Supervisors and team leaders will participate in a "Training of Trainers" (TOT) course, and train spray operators within their respective sub-counties. Training will be conducted according to the WHO's "Manual for Indoor Residual Spraying" (WHO 2002) and H.D. Hudson Manufacturing Company's "Indoor Residual Spray Team Training: A Cascade Training Guide and Checklist."

L. The provisions made for monitoring the use and effectiveness of the pesticide

A comprehensive Human Health and Environmental Evaluation Report will serve to address weaknesses in program implementation and avoid human health and environmental hazards. This comprehensive report will be comprised of the elements in Table 4. Elements of this report will be used throughout operations to determine whether and when corrective or supplementary mitigation actions should be taken. In the form of a comprehensive report, these elements will inform planning for future spray operations.

Table 4. Elements of Human Health and Environmental Evaluation Report.

Environmental Reporting Elements	Purpose	Activities and Responsible Parties
Post-training evaluation of spray operators and supervisors, storekeepers, and medical practitioners	Preliminary assessment of trainees' understanding of training material	Trainers responsible for developing evaluation forms, conducting evaluation, and providing report to program manager and RTI
Post-training evaluation of instructors	Determine effectiveness of training	Program manager responsible for evaluating instructor quality, reporting to RTI
Insecticide sachet accounting	Track insecticide leakage/pilferage	Team leaders and supervisors responsible for recording data and submitting it to logistics coordinator or data manager for data aggregation and reporting to program manager and RTI
Mitigation monitoring reports	Identify gaps in implementation of best practices, need for corrective action	Program manager, logistics manager, and/or select supervisors will be responsible for spot-checks of operations. Data manager responsible for synthesizing data and reporting to

		program manager and RTI
Environmental impact monitoring reports	Determine whether IRS is exposing sensitive species and ecosystems to pesticide	RTI or subcontractor responsible for collecting baseline data, intermittent data during and after spray operations, and reporting to the program manager and RTI
Entomological monitoring reports	Determine effectiveness of IRS on reducing mosquito population	Vector Control Division and National Malaria Control Program of the MOH
Reports on malaria incidence and morbidity	Determine effectiveness of IRS on reducing malaria incidence and morbidity	Health Center heads are responsible for collecting malaria incidence and morbidity data (baseline and subsequent) and sending it to the District Vector Control officer The RTI data manager and DHO counterpart are responsible for synthesizing data, and reporting findings to the program manager and RTI
Post-IRS Campaign survey, assessing KAP of community regarding IRS	Identify information that requires more emphasis or different communication strategy before the next spray season	IEC Sub-contractor responsible for survey design, implementation, data analysis, and reporting

Spot-checks conducted for mitigation monitoring purposes will be conducted on hand-held GPS units and will be based on the spot-check card in Annex 6. In this way, data on mitigation practices can be easily recorded and assessed, and then used to address any divergence (individual and program-wide) from best practices.

Entomological surveys will be conducted to determine the effectiveness of ICON™ WP. One pre-campaign survey will be conducted in May, 2006 and one post-campaign survey will be conducted in August, 2006. These surveys will be conducted in two or three sub-counties in Kabale District. The surveys include the following tests:

- **Trap Collections,** to measure outdoor adult vector densities before and after IRS. These collections will be conducted either without bait or using cattle as bait, and vector mosquitoes will be collected using either a net or a hut. Thus one of the four methods for trap collection will be used:
    1. Cattle-baited hut collection
    2. Cattle-baited net collection
    3. Non-baited hut collection
    4. Non-baited net collection
- **Pyrethrum Spay Catches** (PSCs), to measure indoor vector densities before and after spraying. PSCs will be conducted in different house types to determine if household type is

related to malaria risk, and to determine how IRS operations affect the indoor resting behavior of the vectors.

- **Wall Bioassay Tests**, to determine the potency and the rate of loss potency of insecticide deposits on wall surfaces. Wall bioassays can also be used in assessing whether spraying was satisfactorily conducted or not.
- **Susceptibility Studies,** to detect the presence of resistant vector individuals in the adult population.

The Vector Control Division of the MOH will take responsibility for conducting these tests in the field in collaboration with and under the supervision of the NMCP Entomologist and the Kabale District Vector Control Officer. Technical support for these surveys will be provided by the US Centers for Disease Control and Prevention (CDC), the WHO Uganda Office, and the RTI Program Manager. Depending on the level of funding that CDC can provide, more comprehensive entomological testing can be completed (for example, weekly or fortnightly surveys covering all sub-counties in Kabale District). The team leader for the entomological surveys (From MOH or DHO) must use an NMCP-specified form to record data, and will prepare a report compiling all findings which will then be submitted to the NMCP, VCD, District Vector Control Officer, RTI, and USAID/CDC.

PREPARATION METHODOLOGY

The contents of this PERSUAP are based on direct communication with the MOH National Malaria Control Program (NMCP), the MOH Vector Control Department, the Kabale District Health Office, the Kabale Regional Hospital, the Kabale District Agriculture Office, the PRIME-West Project (USAID), World Vision, the National Environmental Management Authority, and the Uganda Wildlife Authority. The individuals employed by these entities graciously provided information on pesticide and vector control practices to a three-person team consisting of:

Ms. Melanie Biscoe	Environmental Scientist, RTI International
Dr. D.M. Gunawardena	IRS Logistics Consultant, RTI International
Mr. Manuel Lluberas	H.D. Hudson Manufacturing Company

Research for this PERSUAP was conducted over a two-week period from November 1 to 14, 2005. Additionally, government documents concerning pesticide use, the environment, and malaria control were reviewed and incorporated into this PERSUAP.

OTHER SECTIONS

The following sections are typically included in an EA, but are not applicable in this circumstance:

- Conflicts with other policies, plans or controls for the areas under consideration

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ANNEXES

ANNEX 1: Recommended Mitigation Activities in Program Implementation Time Sequences

ANNEX 2: Map of Uganda, UN

ANNEX 3: Parishes of Kabale District, MOH

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ANNEX 1: Recommended Mitigation Activities by Program Implementation Sequence

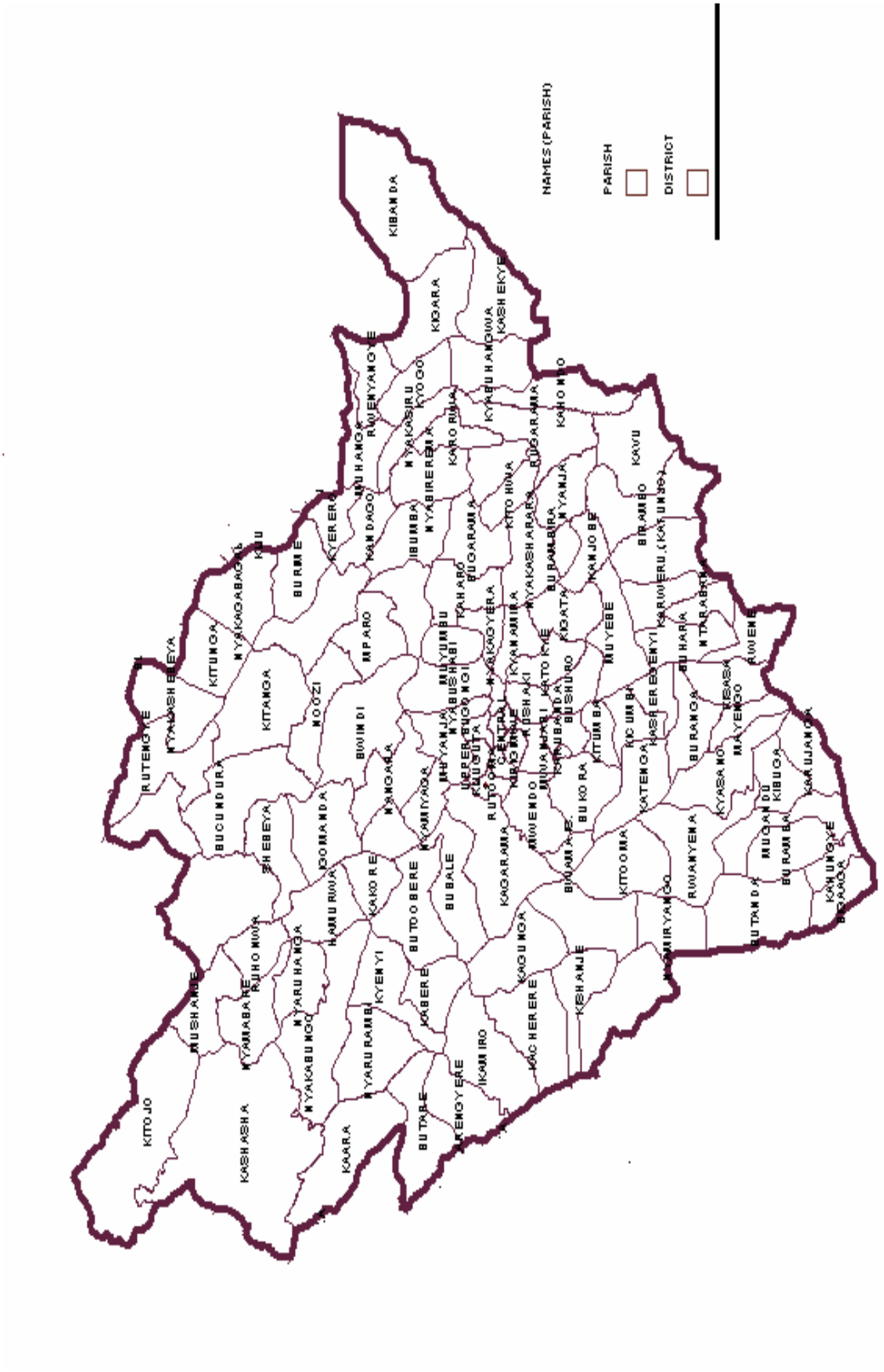
Activities	Responsible Parties
Pre-Spraying Activities	
Training of spray operators, team leaders and supervisors according to WHO and H.D. Hudson Manufacturing Company guidelines.	RTI & Supervisors
Procurement and proper use of Personal Protective Equipment (PPE) by spray operators, team leaders and supervisors (cotton overalls, face mask, broad-rimmed hat, rubber gloves, gum boots)	Logistics Coordinator, Supervisors
Training of health workers in insecticide poisoning treatment	Kabale Regional Hospital, MOH, RTI
Procurement and distribution of treatment medicines for insecticide exposure	MOH and DHO
Hire of commercial laundry or local wash persons (can be spray operators) for proper washing of overalls.	Logistics Coordinator, DHO
If a wash person is hired to clean spray operator PPE, then procurement and wear of PPE by wash person (chemical apron, rubber boots, rubber gloves)	RTI, Supervisors
Development and implementation of environmental reporting system	RTI, Program Manager, Supervisors
Pregnancy tests during initial hiring of spray operators	Program Manager, Logistics Coordinator, Kabale Regional Hospital
Distribution of condoms to women spray operators	Logistics Coordinator, Kabale Regional Hospital
Pregnancy tests one month into spray campaign IEC Campaign, citing importance of removing all food, 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	Logistics Coordinator, Kabale Regional Hospital DHO and Subcontractor
Procurement of seat covers or sheets for covering cloth vehicle seats	Logistics Manager
Procurement and use of gloves for washing interior and exterior of program vehicle	RTI, Supervisor, Driver
Procurement and distribution of materials necessary for collection (in the case of using a commercial laundry for washing spray operator overalls) and decontamination of washtub rinse-water	Logistics Coordinator
Storage of all insecticides, empty packaging, barrels and tubs in storage facilities, reducing use of contaminated goods domestically	Supervisors and/or storekeeper(s)
Inscription of ALL program barrels and tubs as District Health Office property, and labeling with poison stickers, to deter sale and domestic use in event of pilferage	Logistics Coordinator, District Health Office, MOH.

Development and implementation of environmental monitoring plan	RTI, Subcontractor
Development of protocol for decision-making when environmental monitoring indicates environmental contamination as a result of IRS (suggested protocol involves MOH, NEMA, and MOA stakeholder consultation at the District level)	Program Manager, MOH/NMCP, DHO, NEMA, MOA
Renovation of central storage facility	Logistics Coordinator, MOH/NMCP and DHO
Purchase and renovation of cargo containers for storage facilities	Logistics Coordinator, MOH/NMCP and DHO
Procurement and distribution of emergency equipment to insecticide storage facilities	Logistics Coordinator, MOH/NMCP and DHO
Training of storekeepers	RTI and Supervisors
Training of drivers for long-distance transport of insecticide and short-distance transport during the campaign period	n/a
Storage facility sites located on high ground, outside of floodplain	Logistics Coordinator, MOH/NMCP and DHO
Selection of insecticide to minimize resistance and maximize residuality on surfaces sprayed	MOH
Lab-testing of insecticide to ensure quality control	National Drug Authority, Logistics Coordinator
Entomological monitoring of resistance	MOH/NMCP, MOH/DVBD, DHO,CDC, WHO Uganda Office, RTI Program Manager
IEC Campaign, citing importance of not plastering or painting walls after the home has been sprayed	DHO and Subcontractor
Procurement and use of sprayers manufactured according to WHO specifications	RTI and MOH
Importance of an environmental assessment for any pesticides used in IRS will be discussed with MOH and NEMA staff-- online resource for conducting assessments will be provided (http://www.encapafrica.org/)	Program Manager and USAID Environmental Staff
Activities Concurrent with Spraying	
Daily on-site personal washing (post-spraying)	Supervisors
Reprimand of spray operators that do not follow proper procedure in all aspects of operations (handling, spraying, hygiene, cleanup)	Supervisors,DHO, Program Manager
Daily washing of overalls (post-spraying)	Wash Person or Commercial Washing Facility, Supervisor
Progressive rinse of sprayers and PPE	Supervisors
Prohibition of spraying in protected areas/sensitive ecosystems (e.g. non-cultivated wetlands), and spraying with care in residential areas where beekeeping occurs	Supervisors
Prohibition of spraying in homes where sick persons or pregnant women are living and cannot move outside the home *and* stay outside the home during and 1 hour after spraying	Supervisors

Prohibition of 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.	Supervisors
Cover cloth interior seats of program vehicles with seat cover or cloth to prevent seat contamination	Driver
Prior to exterior washing of program vehicles, wipe contaminated bed of truck with damp cloth	Driver
Prior to spraying, covering furniture that cannot be moved with cloths provided by the MOH, District Health Office, or Program (RTI/USAID)	Spray Operator, Supervisor
Daily washing of cloths used to cover furniture	Wash Person or Commercial Washing Facility, Supervisor
Daily collection of laundry rinse-water (from commercial laundry), decontamination of laundry rinse-water, and latrine disposal.	Supervisors
Analysis of decontaminated rinse-water to determine levels of active ingredient.	Logistics Coordinator and Subcontractor
Daily triple-rinsing of contaminated packaging	Supervisors
Shredding of packaging materials, making them unusable (unless barrels used for progressive rinse)	Supervisors
Double-padlocking and guarding of storage facilities	Supervisor, Sub-County government
Supervision of spray operators	Supervisors
Data recording on agricultural insecticides for the purpose of knowing how they may contribute to resistance	Supervisors, Team Leaders
Daily sprayer maintenance	Supervisors
Post-Spraying Activities	
End-of-program cleaning/decontamination of interior and exterior of vehicle	Driver
End-of-campaign washing of seat covers and damp cloths used to wipe seats/bed of program vehicle	Wash Person or Commercial Washing Facility, Supervisor
Transport of rinsed packaging materials to power plant or cement kiln	Logistics Coordinator (MOH and power plant/cement kiln managers need to coordinate)
Submission of environmental reporting to RTI and USAID Mission Environmental Officer	Program Manager
Entomological monitoring of resistance	MOH/NMCP, MOH/DVBD, DHO,CDC, WHO Uganda Office, RTI Program Manager
Non-Time Specific Actions	
Development of a strong malaria surveillance system to target IRS interventions, reducing pesticide use	USAID, MOH, HIMAL, DHO
Pursuit of an integrated strategy involving environmental management and larviciding	MOH
Development of protocol/implementation of measures to mitigate mosquito resistance to insecticides-- pesticide rotation or mosaicing.	MOH

ANNEX 2: Map of Uganda, UN

ANNEX 3: Parishes of Kabale District



ANNEX 4: RTI Toxicological Profile for Lambda-Cyhalothrin

Summary of Insecticide

Chemical History

The synthetic pyrethroid lambda-cyhalothrin is a relatively new addition to this insecticide group. It was developed in 1977 and consists of one enantiomeric (i.e., nonsuperimposable, mirror image) pair of isomers and is a more biologically active form than cyhalothrin (IPCS, 1990a). It is used in the control of pests, including mosquitoes, in agricultural and public and animal health settings (EXTOXNET, 1996). The risks of occupational exposures and exposures to the general public are expected to be very low if proper precautions are followed. At the recommended application rates, lambda-cyhalothrin is not expected to cause adverse environmental effects. As is typical of synthetic pyrethroids, the typical symptoms for acute exposure are neurological and include tingling, burning, or numbness sensations (particularly at the point of skin contact), tremors, incoordination of movements, paralysis or other disrupted motor functions. These effects are generally reversible because lambda-cyhalothrin beaks down rapidly in the body (IPCS, 1990a; EXTOXNET, 1996).

Description of Data Quality and Quantity

Lambda-cyhalothrin and cyhalothrin are basically the same chemical and differ only in their stereo chemistry and the number of isomers in each mixture (U.S. EPA, 2002a). Cyhalothrin consists of four stereo isomers while lambda-cyhalothrin is a mixture of only two isomers. The two lambda-cyhalothrin isomers are contained in cyhalothrin and they represent 40 percent of the cyhalothrin mixture. The majority of toxicity studies available were conducted using cyhalothrin as the test chemical. Evidence based on subchronic studies in rats suggests that the two mixtures are not biologically different with respect to their mammalian toxicity (U.S. EPA, 2002a).

EPA and ATSDR have developed quantitative human health benchmarks for cyhalothrin (EPA's acute and chronic oral RfDs and short-, intermediate-, and long-term dermal and inhalation benchmarks, and ATSDR's acute and subchronic oral MRLs).

Recommended resources include:

Environmental Health Criteria 99: Cyhalothrin (IPCS, 1990a)

Toxicological Profile for Pyrethrin and Pyrethroids (ATSDR, 2003a)

Pesticide Information Profiles (PIP) for Lambda-cyhalothrin (EXTOXNET, 1996)

Specifications and Evaluations for Public Health Pesticides for Lambda-cyhalothrin (WHO, 2003)

Integrated Risk Information System (IRIS) summary review for cyhalothrin (U.S. EPA, 2005a).

Summary Table

Duration	Route	Benchmark Value	Units	Endpoint	Reference
Acute,	Inhalatio	0.0008	mg/kg/day	Inhalation NOAEL for	U.S. EPA

Subchronic, Chronic	n			neurotoxicity in rats at 0.08 mg/kg/day (0.3 µg/L) with uncertainty factor (UF) of 100 applied	(2002a)
Acute	Oral	0.005	mg/kg/day	Acute RfD based on neurotoxicity in dogs	U.S. EPA (2002a)
Subchronic	Oral	0.001	mg/kg/day	Adopt chronic RfD for subchronic duration	
Chronic	Oral	0.001	mg/kg/day	Chronic RfD based on neurological effects in dogs	U.S. EPA (2002a)
Acute, Subchronic, Chronic	Dermal	0.1	mg/kg/day	Dermal NOAEL in rats with UF of 100 applied	U.S. EPA (2002a)

For inhalation exposure, a NOAEL of 0.3 µg/L (0.08 mg/kg/day) was identified for neurotoxicity, decreased body weight, and slight changes in urinalysis parameters in rats exposed to lambda-cyhalothrin via inhalation for 21 days. An uncertainty factor of 100 was applied, for an inhalation benchmark value of 0.0008 mg/kg/day. This value is appropriate for all exposure durations (U.S. EPA, 2002a).

For oral exposure, an acute RfD of 0.005 mg/kg/day was derived based on a NOAEL of 0.5 mg/kg/day for neurotoxicity (ataxia) observed in dogs exposed to lambda-cyhalothrin, with an uncertainty factor of 100 applied (U.S. EPA, 2002a). A chronic oral RfD of 0.001 mg/kg/day was derived based on a NOAEL of 0.1 mg/kg/day for gait abnormalities in dogs exposed to lambda-cyhalothrin, with an uncertainty factor of 100 applied (U.S. EPA, 2002a). The chronic RfD was adopted to represent subchronic exposures.

For dermal exposure, a NOAEL of 10 mg/kg/day was identified in rats dermally exposed to lambda-cyhalothrin for 21 days. An uncertainty factor of 100 was applied, for a dermal benchmark value of 0.1 mg/kg/day. This value is appropriate for all exposure durations (U.S. EPA, 2002a).

Insecticide Background

CAS #: 91465-08-6

Synonyms: none (WHO, 2003)

Chemical Group: synthetic pyrethroid

Registered Trade Names: Charge, Excaliber, Grenade, Karate, Hallmark, Icon, OMS 0321, PP321, Saber, Samurai, Sentinel, and Matador (EXTOXNET, 1996)

Usage

Lambda-cyhalothrin is a synthetic pyrethroid (IPCS, 1990a) most commonly used for pest control, especially mosquitoes; the insecticide is usually sprayed on interior walls or used to impregnate bed nets (EXTOXNET, 1996). This insecticide is a restricted use pesticide, so it can be purchased and used only by certified applicators (EXTOXNET, 1996). Lambda-cyhalothrin has adulticidal, ovicidal, and larvicidal activity (IPCS, 1990a). In addition to mosquitoes, it is effectively used to control: cockroaches, ticks, fleas, aphids, Colorado beetles, cutworms and butterfly larvae (EXTOXNET, 1996; IPCS, 1990a).

Formulations and Concentrations

There are several formulations for lambda-cyhalothrin, each containing varying amounts of the active ingredient. The typical formulations for lambda-cyhalothrin are

Technical grade (not less than 810 g/kg lambda-cyhalothrin)

Emulsifiable concentrate (at 20 +/- 2^{o}C: up to 25 g/l +/- 15% declared content; > 25 g/l to 100 g/l +/- 10% of declared content)

Wettable powder (up to 25 +/- 15% of declared content: > 25-100 +/- 10 % of declared content)

Slow release capsule suspension (at 20 +/- 2^{o}C: up to 25 g/l +/- 15% declared content).

The main formulation used for agricultural purposes is the emulsifiable concentrate. The wettable powder formulation is mainly used for public health reasons (WHO, 2003). Lambda-cyhalothrin is commonly mixed with buprofezin, pirimicarb, dimethoate, or tetramethrin, resulting in the usual product (WHO, 2003; EXTOXNET, 1996).

Shelf-Life

This insecticide, like many others, needs to be stored in a cool, dry, and well-ventilated facility (IPCS, 1990a). Lambda-cyhalothrin should not be stored or transported with foodstuffs and household supplies to the limit the potential for cross contamination and human exposure (IPCS, 1990a).

Degradation Products

In the environment, lambda-cyhalothrin degrades through biological and photochemical reactions (IPCS, 1990a). Biological reactions are thought to be more important. Lambda-cyhalothrin will degrade rapidly in soils, remain relatively stable in water, and is usually not found in air due to its low vapor pressure. The main degradation products are 3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2, 2-dimenthyl-cyclopropanecorboxylic acid, the amide derivative of cyhalothrin, and 3-phenoxybenzoic acid. The degradation is a result of the cleavage of the ester linkage to give two main degradation products, which are further degraded to carbon dioxide. Lambda-cyhalothrin degrades fairly quickly in alkaline conditions, in comparison to neutral or acidic media. It is strongly absorbed in soils and sediments with little tendency for bioaccumulation (IPCS, 1990a).

In water, lambda-cyhalothrin is stable at pH 5. Racemization at the alpha-cyano carbon occurs at pH 7 to pH 9, creating a one to one mixture of enantiomer pairs A and B. The ester bond is hydrolysed at pH 9. Additionally, a moderately high rate of photolysis is seen in dilute aqueous solutions (IPCS, 1990a).

Environmental Behavior

Fate and Transport in Terrestrial Systems

In most soil types, lambda-cyhalothrin is not very mobile. Its high reported organic carbon partitioning coefficient (Koc) value reflects its strong affinity for soil. It is retained more in soil with low sand content or high organic matter content (EXTOXNET, 1996). Studies have shown that lambda-cyhalothrin and its degradation products do not leach through soils into groundwater nor are they transported to other compartments of the environment following agricultural uses (IPCS, 1990a).

Lambda-cyhalothrin is moderately persistent in soil with a soil half-life ranging from 4 to 12 weeks. A longer in-field half-life of approximately 30 days is reported for most soils (EXTOXNET, 1996). The half-life is variable because it is dependent on the availability of sunlight, which speeds degradation (IPCS, 1990a).

Fate and Transport in Aquatic Systems

Lambda-cyhalothrin is not expected to be prevalent in surface or groundwater because it has extremely low water solubility and binds tightly to soil. Lambda-cyhalothrin enters surface water largely through surface runoff. Even so, lambda-cyhalothrin is most likely to stay bound to sediment and settle to the bottom. Studies have shown that hydrolysis of lambda-cyhalothrin occurs rapidly at a pH of 9 but not at a pH of 7, though isomerization was observed at a pH of 7. No hydrolysis or isomerization was seen at a pH of 5.

Human Health Effects

Acute Exposure

Effects/Symptoms

No data on accidental human poisonings have been reported. Additionally, no quantitative epidemiological studies are available (IPCS, 1990a). However, under normal use conditions, acute exposure to lambda-cyhalothrin is not expected to represent a hazard in humans. Transient skin sensations such as periorbital facial tingling and burning have been reported following direct skin exposure in laboratory workers and manufacturing workers handling synthetic pyrethroids. This sensation is possibly due to repetitive firing of sensory nerve terminals and usually lasts for a few hours up to 72 hours post-exposure. No neurological abnormalities have been observed upon medical examination (IPCS, 1990a). Lambda-cyhalothrin can irritate the eyes, skin, and upper respiratory tract. Additionally, oral exposure can cause neurological effects, including tremors and convulsions. Ingestion of liquid formulations may result in aspiration of the solvent into the lungs, resulting in chemical pneumonitis. Based on the acute oral toxicity data, lambda-cyhalothrin has been classified as "Moderately Hazardous" (Class II) (WHO, 2003).

In animals, the technical form of lambda-cyhalothrin is moderately toxic; however, toxicity depends on both the formulation (concentration of active ingredient and solvent vehicle) and the route of exposure (EXTOXNET, 1996). Laboratory data indicate that acute oral exposure to lambda-cyhalothrin is moderately to highly toxic in rats and mice and that mice are more susceptible to the toxic effects than rats (WHO, 2003). The oral LD_{50} for lambda-cyhalothrin in corn oil has been reported to range from 56 mg/kg in female rats up to 79 mg/kg in males. A similar LD_{50} is reported for technical grade lambda-cyhalothrin in rats at 64 mg/kg (EXTOXNET, 1996). The oral LD_{50} in mice is reported as 20 mg/kg (IPCS, 1990a). The effects of acute oral exposure are typical of pyrethroid toxicity, including abnormal motor function (WHO, 2003).

Acute inhalation exposures are also highly toxic to animals (WHO, 2003). In the formulated product Karate, the 4-hour LC_{50} in rats is reported as 0.175 mg/L in females and 0.315 mg/L in males (EXTOXNET, 1996).

Lambda-cyhalothrin is less toxic in animals via acute dermal exposure (WHO, 2003). In rats, dermal LD_{50}s of 632 mg/kg for males and 696 mg/kg for females have been reported for the technical product. Studies have also shown the technical product produced no skin irritation to rabbits and is nonsensitizing in guinea pigs. Mild eye irritation was observed in rabbits. However, dermal exposure to the formulated product Karate causes severe primary skin irritation in rabbits and mild skin sensitization in guinea pigs.

Other acute dermal effects are related to the nervous system and include tingling, burning sensations, or numbness (EXTOXNET, 1996).

Treatment

Lambda-cyhalothrin and its breakdown products can be detected in blood and urine, but only within a few days of the last exposure (ATSDR, 2003a). Dermal exposure to lambda-cyhalothrin exposure should be treated by removing contaminated clothing and washing the exposed areas with soap and water. If lambda-cyhalothrin gets into the eyes, they should be rinsed with water for several minutes. Contact lenses should be removed if possible and medical attention should be sought. Vomiting should not be induced following ingestion of lambda-cyhalothrin, and medical attention sought. Inhalation exposures require removal to fresh air and rest (IPCS, 1990b)

Chronic Exposure

Noncancer Endpoints

Based on the available data, it is unlikely that lambda-cyhalothrin would cause chronic effects in humans under normal conditions. No specific target organs have been identified in the available chronic studies (EXTOXNET, 1996). Decreased body weight gain and mild neurological effects have been observed in some animal studies (EXTOXNET, 1996; IPCS, 1990a).

Lambda-cyhalothrin is not expected to be teratogenic, mutagenic, or genotoxic in humans. Studies in animals have found no teratogenic or fetotoxic effects in rats or rabbits. Additionally, it was negative in five test strains in the Ames mutagenicity assay (IPCS, 1990a). No mutagenic or genotoxic effects were seen in other in vitro cytogenic assays or chromosomal aberration tests (EXTOXNET, 1996).

Cancer Endpoints

Data on the carcinogenic potential suggest that lambda-cyhalothrin is not carcinogenic in humans. In rats and mice exposed to cyhalothrin, no carcinogenic effects were observed. EPA has classified lambda-cyhalothrin as a Group D chemical, "not classifiable as to human carcinogenicity" (U.S. EPA, 2002a).

Toxicokinetics

Animal studies have been have been conducted in various species to investigate the toxicokinetics of cyhalothrin and lambda-cyhalothrin. Oral cyhalothrin is readily absorbed, metabolized thoroughly, and eliminated as polar conjugates in the urine (IPCS, 1990a). Studies with lambda-cyhalothrin have shown that it also is rapidly metabolized into less toxic water-soluble compounds and excreted in the urine and feces (EXTOXNET, 1996). In mammals, cyhalothrin is metabolized as a result of ester cleavage to cyclopropanecarboxylic acid and 3-phenoxybenzoic acid, and eliminated as conjugates. Tissue levels decline after exposure stops and residues in the body are low (IPCS, 1990a).

Ecological Effects

Acute Exposure

Toxicity to Non-Target Terrestrial Organisms

Like other synthetic pyrethroids, lambda-cyhalothrin has been shown to be toxic to honey bees but has little effect on birds and domestic animals (EXTOXNET, 1996). In birds, the toxicity of lambda-

cyhalothrin ranges from nontoxic to slightly toxic. Oral LD_{50} values in mallard duck are reported as greater than 3,950 mg/kg. Dietary LC_{50} values of 5,300 ppm are reported in bobwhite quail. Additionally, there is no evidence of lambda-cyhalothrin accumulation in bird tissues or in eggs (EXTOXNET, 1996). Lambda-cyhalothrin has shown mixed toxicity to other non-target terrestrial organisms. It is extremely toxic to honey bees, with a contact LD_{50} of 0.9 µg/bee and an oral LD_{50} of 38 ng/bee (EXTOXNET, 1996), but has no adverse effect on earthworms (IPCS, 1990a).

Toxicity to Aquatic Organisms

Like other synthetic pyrethroids, lambda-cyhalothrin has been shown to be quite toxic under laboratory conditions to both cold and warm water fish. Acute 96-hr LC_{50} values range from 0.2 to 1.3 µg/L. It is also highly toxic to aquatic arthropods with 48-hr LC_{50} ranging from 0.008 to 0.4 µg/L (IPCS, 1990a; WHO, 2003). In the field, however, these effects are not likely to occur under the recommended use scenarios (WHO, 2003). No serious adverse effects have been observed due to the low rates of application and the lack of persistence in the environments (IPCS, 1990a). Accumulation studies have shown that although bioaccumulation is possible in fish, it is unlikely due to the rapid metabolism of lambda-cyhalothrin (EXTOXNET, 1996).

Chronic Exposure

Toxicity to Non-Target Terrestrial Organisms

No data were located on the chronic toxicity to non-target terrestrial organisms.

Toxicity to Aquatic Organisms

No data for chronic duration exposures of aquatic organisms were located; however, a subchronic study in Sheepshead minnow embryos and larvae showed no effect on hatchability or larval survival when exposed to up to 0.25 µg/L through 28 days post hatching. A significant effect on larval weight was observed at 0.38 µg/L. In an additional subchronic exposure study, survival, growth, and reproduction of *Daphnia magna* were seen at 40 ng/L but not at 2.5 ng/L (IPCS, 1990a).

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ANNEX 5: Treatment Guidelines for Lambda-Cyhalothrin, IPCS

Guidelines for Treatment of Exposure to Lambda-Cyhalothrin

From the International Programme on Chemical Safety

Toxicity

Dermal and inhalational exposures are associated usually with no or only mild adverse effects. Following substantial ingestion, patients may develop coma, convulsions and severe muscle fasciculations and may take several days, occasionally weeks, to recover.

Fatalities have occurred rarely after pyrethroid exposure, usually following ingestion (He et al, 1989). No known fatalities have been reported after lambda-cyhalothrin exposure.

Symptoms

Dermal exposure
Tingling and pruritus with blotchy erythema on the face or other exposed areas, exacerbated by sweating or touching. Systemic toxicity may ensue following substantial exposure (see below).

Ocular exposure
Lacrimation and transient conjunctivitis may occur.

Inhalation
For brief exposure, respiratory tract irritation with cough, mild dyspnoea, sneezing and rhinorrhea. For substantial and prolonged exposure, systemic toxicity may ensue - see below.

Ingestion
May cause nausea, vomiting and abdominal pain. Systemic toxicity may ensue following substantial ingestion (see below).

Systemic toxicity
Systemic symptoms may develop after widespread dermal exposure, prolonged inhalation or ingestion. Features include headache, dizziness, anorexia and hypersalivation. Severe poisoning is uncommon. It usually follows substantial ingestion and causes impaired consciousness, muscle fasciculations, convulsions and, rarely, non-cardiogenic pulmonary oedema.

Chronic exposure
Long-term exposure is no more hazardous than short-term exposure.

Treatment

Dermal

1. Remove soiled clothing and wash contaminated skin with soap and water.
2. Institute symptomatic and supportive measures as required.
3. Topical vitamin E (tocopherol acetate) has been shown to reduce skin irritation if applied soon after exposure (Flannigan et al, 1985).
4. Symptoms usually resolve within 24 hours without specific treatment.

Ocular

1. Irrigate with lukewarm water or 0.9 per cent saline for at least ten minutes.
2. A topical anaesthetic may be required for pain relief or to overcome blepharospasm.

3. Ensure no particles remain in the conjunctival recesses.
4. Use fluorescein stain if corneal damage is suspected.
5. If symptoms do not resolve following decontamination or if a significant abnormality is detected during examination, seek an ophthalmological opinion.

Inhalation

1. Remove to fresh air.
2. Institute symptomatic and supportive measures as required.

Ingestion

1. Do not undertake gastric lavage because solvents are present in some formulations and lavage may increase risk of aspiration pneumonia.
2. Institute symptomatic and supportive measures as required.
3. Atropine may be of value if hypersalivation is troublesome, 0.6-1.2 mg for an adult, 0.02 mg/kg for a child.
4. Mechanical ventilation should be instituted if non-cardiogenic pulmonary oedema develops.
5. Isolated brief convulsions do not require treatment but intravenous diazepam should be given if seizures are prolonged or recur frequently. Rarely, it may be necessary to give intravenous phenytoin or to paralyze and ventilate the patient.

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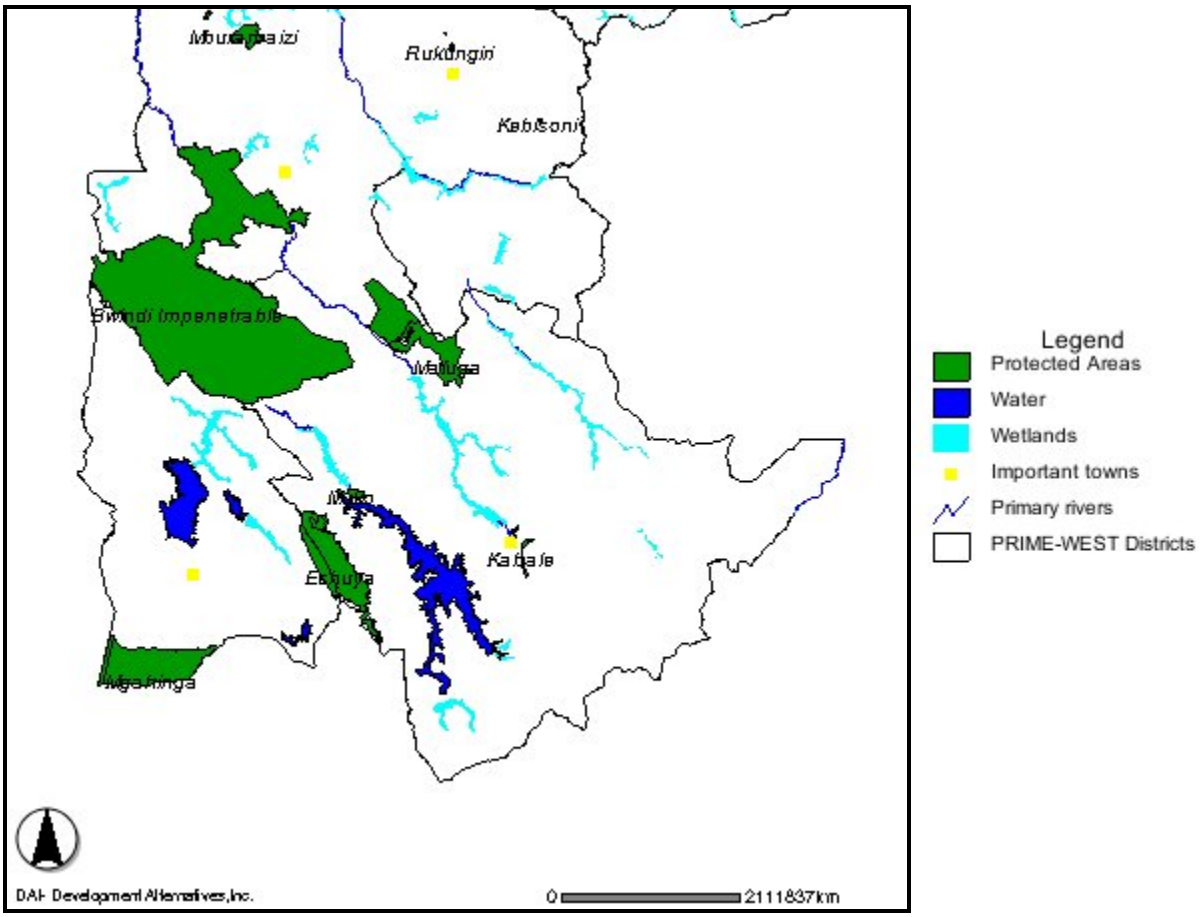
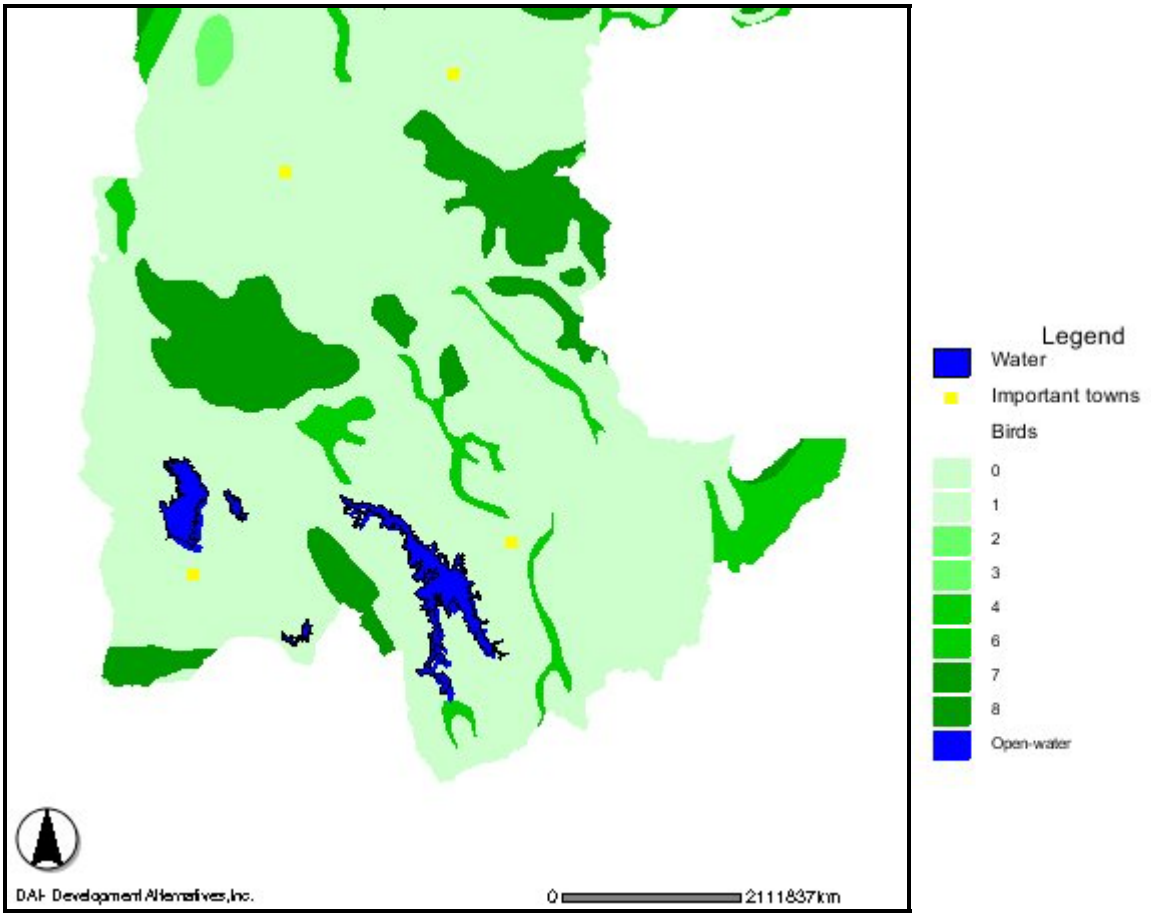
ANNEX 6: Sample of Mitigation Practice Spot-Check Card

Activity	Best Practice	Best Practices Followed?		Corrective Action Taken
House Preparation	Furniture Moved	Yes	No	
	Foodstuffs/Utensils not moved	Yes	No	
	Cloth covering furniture	Yes	No	
PPE Worn	Hat	Yes	No	
	Gloves	Yes	No	
	Facemask	Yes	No	
	Overalls	Yes	No	
	Boots	Yes	No	
Personal Hygiene	No eating/chewing	Yes	No	
	No drinking	Yes	No	
	No smoking	Yes	No	
	No wiping part of body with contaminated clothing	Yes	No	
	No touching nozzle to mouth	Yes	No	
Sprayer Calibrated		Yes	No	
Spraying	Correct distance from wall	Yes	No	
	Correct rhythm	Yes	No	
	Proper surface sprayed	Yes	No	
	Gaps in sprayable surface	Yes	No	
Maintenance of Sprayers	Body rinsed (progressive rinse)	Yes	No	
	Nozzle rinsed (progressive rinse)	Yes	No	
	Nozzle does not need replacing	Yes	No	
	Filter/strainer cleaned	Yes	No	
	Filter present	Yes	No	
	Hose not worn	Yes	No	
	Hose connection tight	Yes	No	
	Trigger operation smooth	Yes	No	
	Seal or washer condition good	Yes	No	
	No leaks	Yes	No	
	Trigger valve/pressure release valve	Yes	No	
Wash-up		Yes	No	
Storage Facility	Orderly	Yes	No	
	Double-padlocked	Yes	No	
	Guarded	Yes	No	
	No spills or leaks	Yes	No	
	Stock record sheet up-to-date	Yes	No	
	Emergency equipment present	Yes	No	
Decontamination/ Disposal	Progressive rinse or decontamination/latrine disposal	Yes	No	(If no, was the water dumped on ground or body of water?)

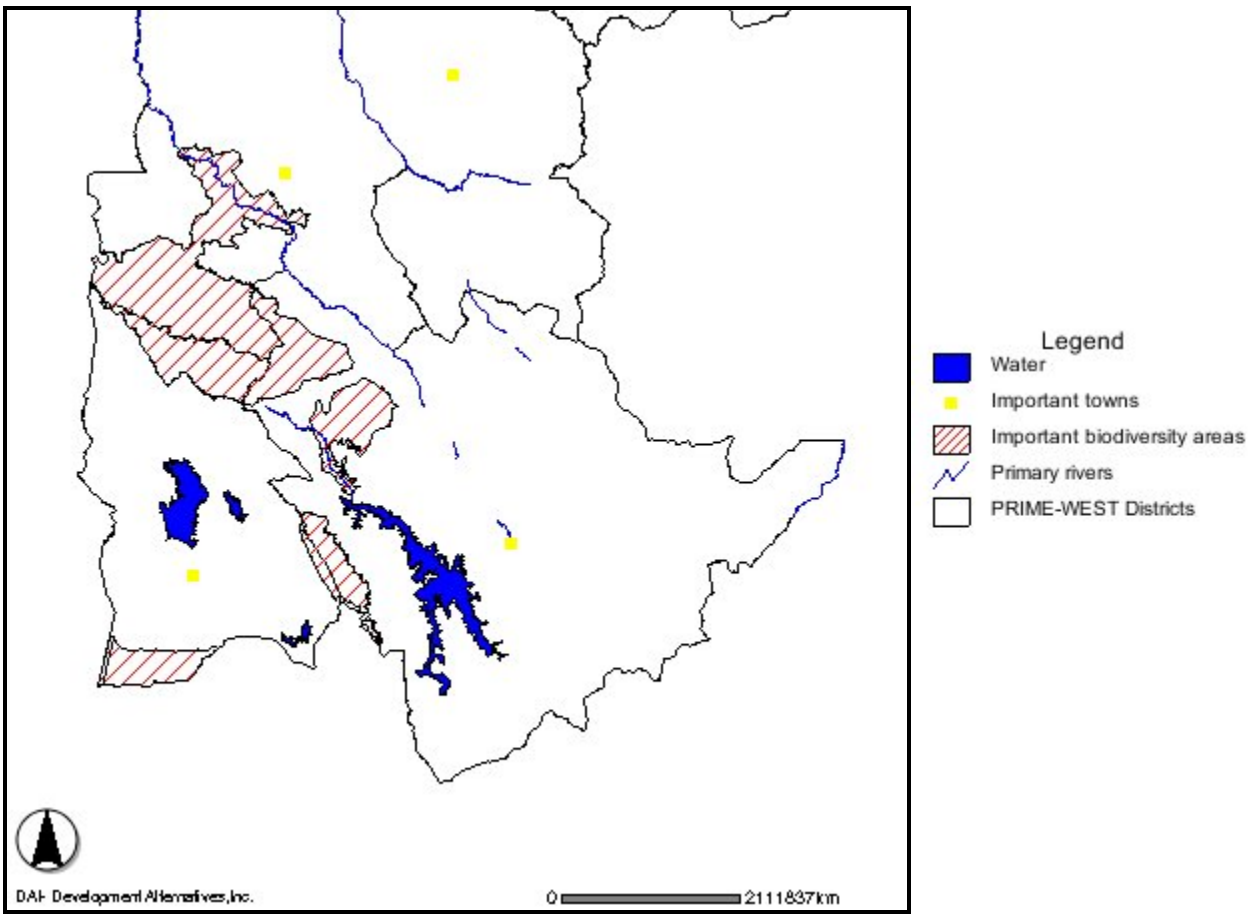
ANNEX 7: Protected Areas and Wetlands, Kabale District, PRIME-West (USAID)



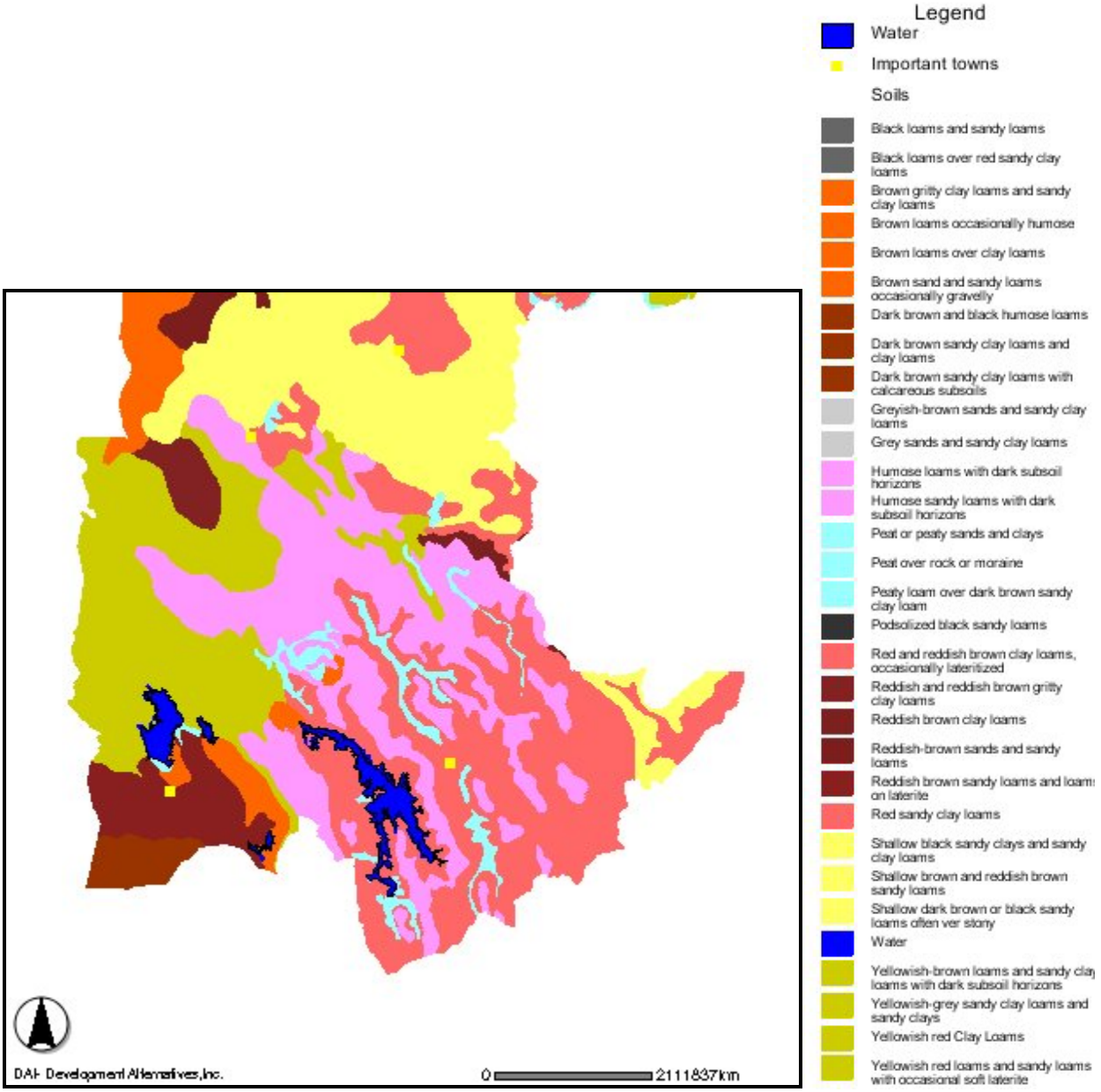
ANNEX 8: Bird Diversity in Kabale District and Surrounding Areas, PRIME-West (USAID)



ANNEX 9: Important Biodiversity Areas, Kabale District, PRIME-West (USAID)



ANNEX 10: Soils Map, Kabale District and Surrounding Areas, PRIME-West (USAID)



ANNEX 11: Pesticide Storage and Stock Control Manual, FAO

Foreword

This manual was prepared by the Food and Agriculture Organization of the United Nations (FAO) under project GCP/INT/572/NET: "Prevention and disposal of obsolete and unwanted pesticide stocks in Africa and the Near East", funded by the Government of the Netherlands. It was written by the National Resources Institute (NRI), Chatham, United Kingdom, with added and editorial input from the FAO Plant Protection Service (AGPP). All the drawings were contributed by an NRI graphic artist.

Despite the limited geographical scope of the project, the manual is considered applicable and useful in many countries particularly in the management and stock control of stored pesticides.

It has been published for distribution to Member Countries of FAO. In view of the fundamental importance of pesticide management, it would be useful to have feedback that could be used in future revisions of this manual. Reference should also be made to FAO's Provisional guidelines: prevention of accumulation of obsolete pesticide stocks, published at the end of 1995, and Technical guidelines on disposal of bulk quantities of obsolete pesticides in developing countries, a joint FAO/UNEO/WHO publication expected in 1996. Comments or suggestions may be addressed to:

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Plant Production and Protection Division
FAO
Viale delle Terme di Caracalla
00100 Rome, Italy
Telex 610181 FAO I
Fax (39-6) 52256347

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Abbreviations

DLCO - EA Desert Locust Control Organization for Eastern Africa

ec emulsifiable concentrate

FAO Food and Agriculture Organization of the United Nations
GIFAP International Group of National Associations of Agrochemical Manufacturers
ILO International Labour Organisation
LD50 the dose of a substance that causes death in 50 percent of a sample of test animals
NRI Natural Resources Institute
OP organophosphate
PVC polyvinyl chloride
UNEP United Nations Environment Programme
WHO World Health Organization
wp Wettable powder

Introduction

Most pesticides are chemicals that are used to kill pests. Among these are insecticides, fungicides, herbicides, nematicides, rodenticides, acaricides and molluscicides, which are used to kill, respectively, insect pests, fungal diseases, weeds, nematodes, rats and mice, mites and ticks and snail disease vectors. They may also kill other organisms, and most are poisonous to humans.

The World Health Organization estimated (WHO, 1986) that 1 million people are affected by insecticide poisoning every year and that 20 000 die as a result of being unaware of the risks involved in handling insecticides. Pesticides are classified by WHO on the basis of their oral or dermal lethal dose (LD). A measurement called the LD50 is calculated by measuring the number of milligrams of active ingredient per kilogram of body weight required to kill 50 percent of a test sample of animals - often rats. Each insecticide is then put into one of four classifications: Class Ia is extremely hazardous; Ib, highly hazardous; II, moderately hazardous; and III, slightly hazardous.

Pesticides usually have to be stored before use. The following account illustrates how essential careful pesticide storage practice and stock control are, especially when extremely hazardous chemicals are involved.

The incident was recounted in 1978 by a storekeeper. He had heard that metal drums of the pesticide dieldrin (a very dangerous organochlorine which is no longer used because of its detrimental effect on the environment), had been kept for some years in a pesticide store with a leaking roof. The drum lids had partially rusted and corroded. When, in order to inspect outdated drums at the rear of the store, a storekeeper's assistant climbed up and jumped across the drums at the front, the lid of one gave way as he landed on it. The assistant plunged down into the dieldrin solution which came up to his waist. Within a few hours he had died of poisoning as a result of pesticide inhalation and absorption through the skin.

Pesticide Stores

Choice of site

The site for a new pesticide store should not be close to dwellings or to hospitals, schools, shops, food markets, animal feed depots and general stores (Figure 1).

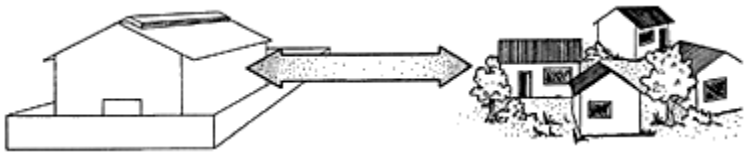


FIGURE 1 - The pesticide store should be located far from human dwellings

It should be faraway from water courses, wells and other supplies of water for domestic and stock animal use because these could be contaminated by spillage and leaks from the store (Figure 2).

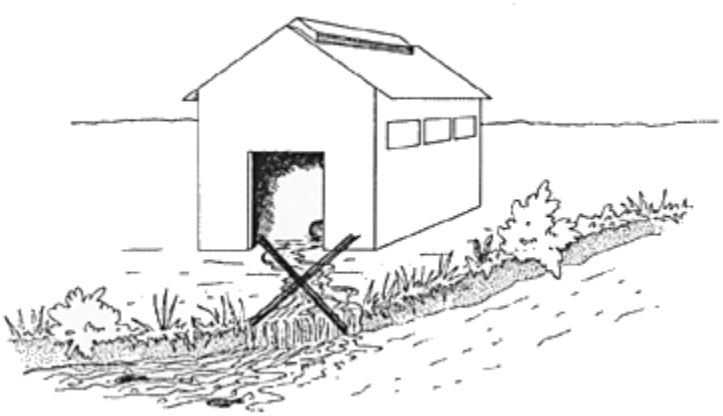


FIGURE 2 - The pesticide store should be sited far from rivers and bodies of water, to prevent chemical contamination
from entering and poisoning the water

The site should not be in an area with high groundwater levels, which may be subject to seasonal flooding (Figure 3), nor should it be adjacent to a seasonal flood course.

FIGURE 3 - The pesticide store should not be sited in an area subject to flooding,
especially during seasonal rains

There should be easy access for pesticide delivery vehicles. Ideally, there should be access on at least three sides of the building for fire-fighting vehicles and equipment in case of emergency (Figure 4).

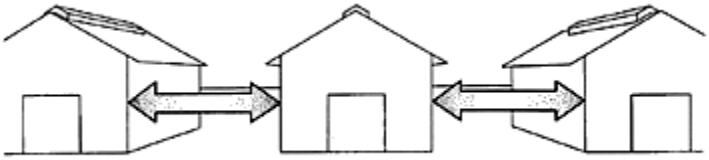


FIGURE 4 - The pesticide store should have three sides free to allow access to fire-fighting equipment in an emergency

Design and structure of buildings

General principles

The store should be large enough to accommodate the quantities of pesticides planned for storage. A further 15 percent capacity should be included to allow for stock movement and possible future needs, in addition to space for dispensing and repacking insecticides and for empty containers. It should also be well ventilated, to prevent the buildup of pesticide vapour and to stop temperatures getting too high, especially in tropical and subtropical countries with a normally high daytime air temperature. The floors should be of smooth, impermeable concrete to avoid absorption of spillages and to allow easy cleaning (Figure 5).

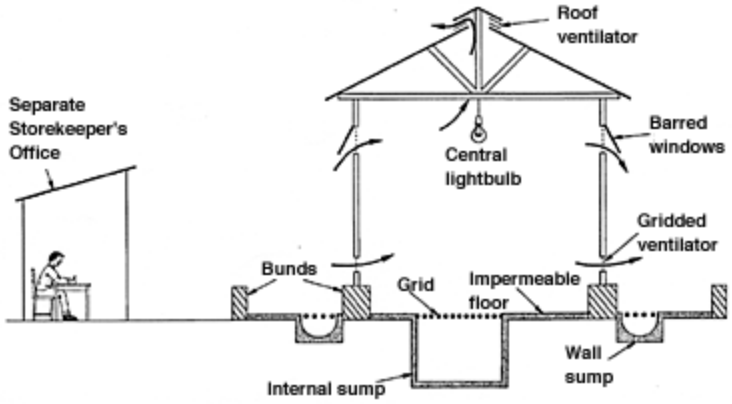


FIGURE 5 - Diagram of a pesticide store showing building features, with storekeeper's office separate from the store (not to scale)

Layout

The layout (Figure 6) should allow for:

- minimum handling of pesticide containers to avoid causing leaks and spills;
- direct access to the outside without passing through another building;
- a well-lit and ventilated working area for dispensing and repacking pesticides some distance from the store entrance;
- space for storing empty containers and out-of-date stock awaiting disposal.

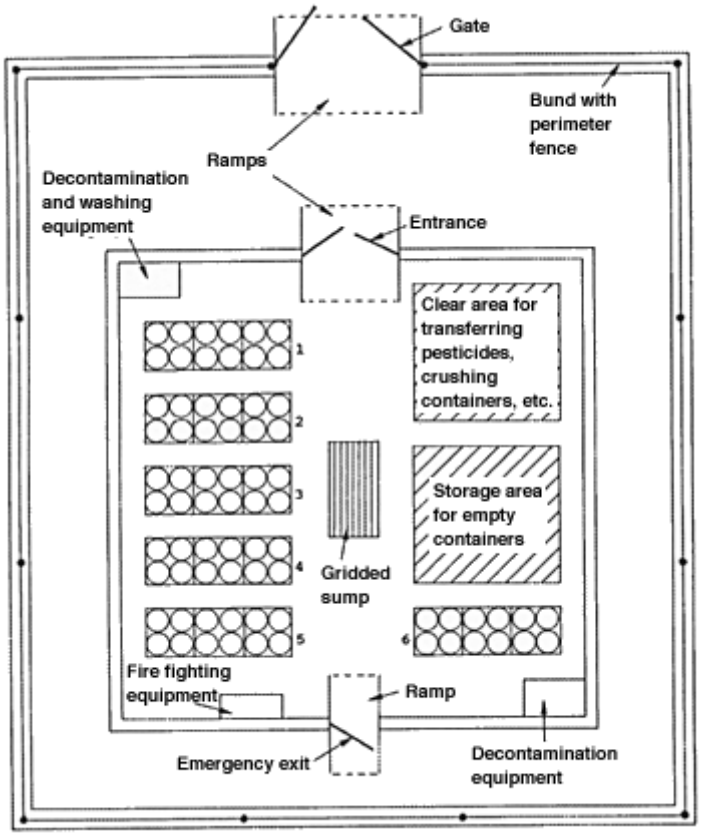


FIGURE 6 - Store layout to show arrangement of facilities (not to scale)

The storekeeper's office should be separate from the storage area. Washing facilities should be provided, with alternative arrangements if there is no piped water supply. Protective clothing should be stored separately from pesticides.

Herbicides should not be stored together with insecticides or other pesticides such as rodenticides and fungicides (Figure 7) so that those that are not poisonous to humans are not contaminated by hazardous chemicals.

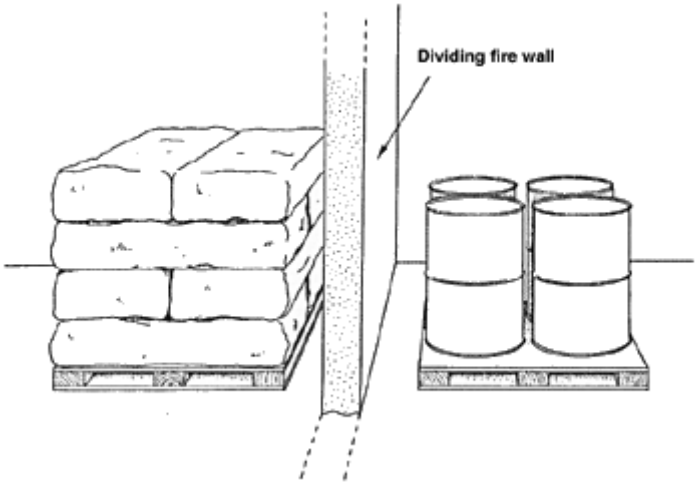


FIGURE 7 - Store dividing wall separating different types of pesticides
and acting as an internal fire-break

Structure

Ideally, the roof should be of light material, such as asbestos substitute or glass fibre, which collapses in the event of fire to allow smoke and fumes to get out and to avoid explosions. The material should not be so flimsy, however, that it is blown away during severe seasonal storms or cyclones.

The store walls should have outside sills that direct spilled chemicals into a sump.

Internal walls should be smooth and free from cracks and ledges to allow easy cleaning.

Windows should not be built if there are alternative means of ventilation and lighting; otherwise they should be shaded (to prevent sunlight from heating the chemicals and causing them to degrade) and barred against unauthorized entry.

The store should be well lit with natural or electric lighting (200 lux) to permit container labels to be read easily.

As sparks can cause fires, electrical fittings should be mineral insulated or armoured cable should be used with flame/dust-proof fittings.

The floor should be made of impervious material or of slats over a concrete-lined sump into which chemical spills can drain to be neutralized. The floor area should be slightly raised at the edges to prevent spills from leaking out of the building and floodwater from getting in. Store walls should be set on bunds, lined to a height of 14 cm with impervious material. A bund around the whole area to contain the store contents is desirable as a further precaution to reduce the risk of gross environmental contamination. Store and perimeter fence bunds should be fitted with concrete ramps to allow vehicle access (Figure 8).

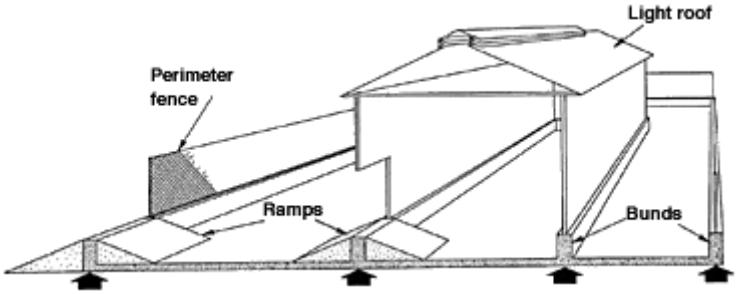


FIGURE 8 - Pesticide store with bunding of walls and perimeter fence including ramps

A static or piped water supply, with soap, should be available for hand and face washing and for decontamination of personnel accidentally splashed by chemicals.

There should be a concrete-lined exterior sump into which spills and leaks can be directed for neutralization and removal. Contaminated water should not be allowed to enter the main drainage system or water courses, but should be directed by sills into sumps.

There should be walls between sections to act as fire-breaks (Figure 9).

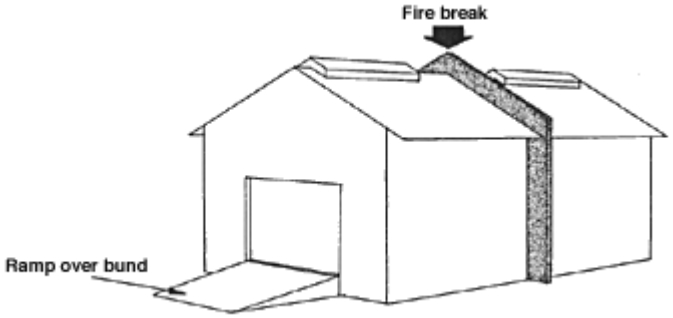


FIGURE 9 - Fire-break in a pesticide store

There should be an emergency exit in addition to the entrance doors, preferably at the other end of the store.

Ventilation is one of the most important requirements within the store as it prevents the buildup of vapours. Toxic vapours may affect the health of store-workers and inflammable vapours are a fire risk. Ventilation also keeps the store as cool as possible. This is important as pesticides deteriorate more slowly and therefore last longer in a cooler environment. Many pesticides are destabilized by high temperatures, which in exceptional cases may even cause explosions.

The ventilation area should be equivalent to 1/150 of the floor area, or outside doors should be open for at least six hours per week. Exhaust fans should be fitted to large stores, preferably on a time switch. Roof- and floor-level ventilation (gridded to prevent the entry of birds and rats) is required to extract light fumes, hot air and heavy vapours.

Temporary storage

Temporary storage of pesticides away from a main store may be required during certain operations such as locust control. The basic principles still apply: keep the pesticides secure (fenced-in or locked inside a vehicle); store them indoors or under a roof to avoid direct sunlight exposure; keep them dry, cool and well-ventilated, especially when they are stored in a vehicle which may become hot if left in the sun.

Notices

A notice should be displayed on the outside of the store in the local language(s) with a skull and crossbones sign. The notice should read: "Danger pesticides. Authorized entry only".
Strategically placed signs should be visually obvious and placed on the inside and outside of pesticide stores. These should read: "No smoking: no naked or half-dressed flame".

There should also be a list of colour codes on display in the store and on containers. Sticky labels for placing on metal and plastic containers are available. The lists in Figure 10 are included with GIFAP (1988a).

Hazard Label	Hazard Class	Method of storage
	2 (In)flammable gas (red backgroud)	Segregate; explosion-proof equipment or open-air storage needed
	3 (In)flammable liquids; flashpoint 55°C or lower (red background) (3 Combustible liquids; flashpoint over 55°C)	Not exceed 250 tonnes unless fire-protected Recommended not to exceed 250 tonnes
	4.1 (In)flammable solids (vertical red and white background)	Recommended not to exceed 250 tonnes
	4.2 Spontaneously combustible (lower half red, upper half white)	Segregate, open-air storage recommended
	4.3 Dangerous when wet (blue background)	Segregate; no sprinkler! protect from rain
	5 Oxidizing substances (yellow background)	Separate from flammables or combustibles

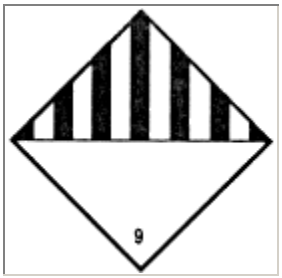
	6.1 Poisonous substances (white background)	Legal requirements may demand segregation if highly toxic (LD_{50} oral < 25 mg/kg)
	8 Corrosives (white and black background)	Separate from pesticides packed in metal
	(white background) Various dangerous substances	
	(white and black background)	No limit; if non-combustible, use as a barrier for separation

FIGURE 10 - Warning signs for display in stores and on containers

Notes
Inflammable ans flammable have the same meaning (British and American usage).
Segregation means storing apart in different rooms with a fire-wall as barrier. Separation means storing apart in different parts of the same room.
After GIFAP, 1988

Storage of Pesticides

As a general principle, systems of storage should be flexible and adaptable.

Stacking positions and heights

Stock should be arranged to use the oldest first ("first in first out" principle) and to prevent obsolete stock from accumulating. Containers should be arranged to minimize handling and thus avoid mechanical damage giving rise to leaks. Floor spaces should be uncluttered, with marked, 1-m wide, gangways between shelves or stacks (Figure 11) that permit easy inspection and allow free air flow (Figure 12). This also enables immediate clean-up in the event of any leakage or spills, which can be seen quickly. Climbing on pesticide containers to reach other containers should not be necessary - damaged or corroded metal drums can easily give way under a person's weight and this leads to potentially fatal gross contamination with pesticide.

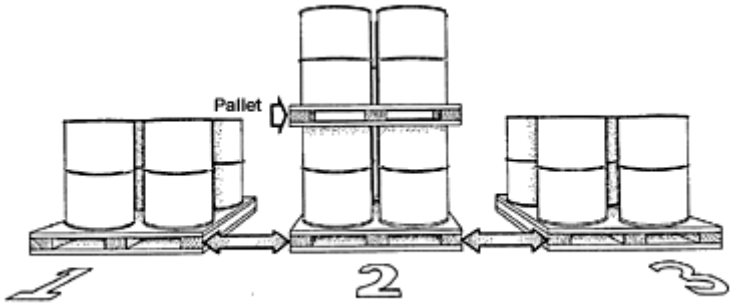


FIGURE 11 - Marked and numbered rows of stacked metal containers of pesticides with pallets below

FIGURE 12 - Aisle space to allow free air flow and access between rows of stacked pesticides

Dunnage (timber and bricks) should be used so containers are not placed directly on the floor. Stacked containers should be on pallets (Figure 13). Corrosion resulting from rising damp or leaking chemicals should be promptly observed and dealt with appropriately.

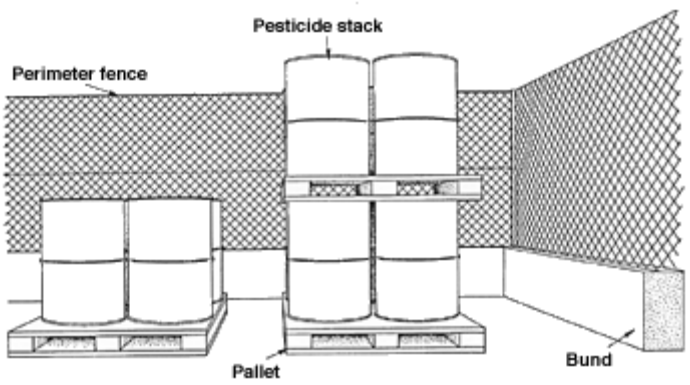


FIGURE 13 - Outside storage (temporary) of pesticides with perimeter fence and arrangement of pallets similar to that inside

Dust, granule and wettable powder formulations should be kept in cartons during storage to avoid caking. Concentrate formulations, especially those in glass bottles, should also be kept in cartons to avoid breakage.

Storage shelves should not exceed a height of 2 m to avoid the use of ladders.

Containers should not exceed a height of 107 cm on each pallet. Containers and cartons should be stacked at safe heights ensuring that they are stable (Figure 14). The safe height depends on container material (Table 1).

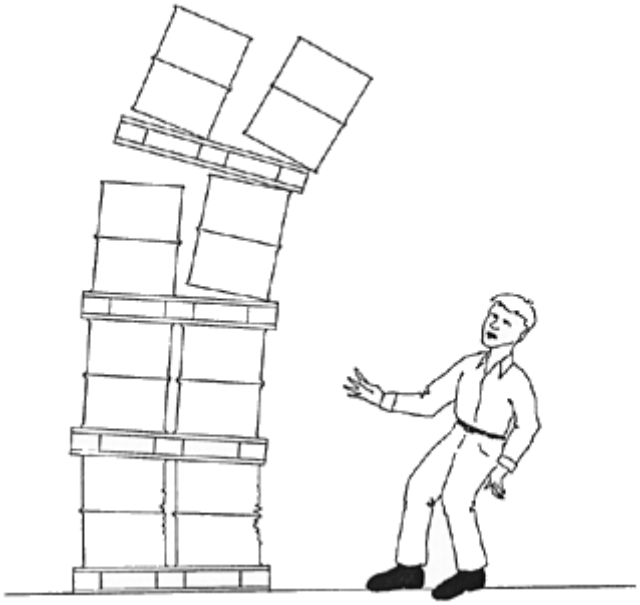


FIGURE 14 - Stacks that are too high become unwieldy and containers lower down are crushed

TABLE 1
Maximum stacking of containers on top of each other

Package type	Number of layers on basal pallet	Palletized: number of packages on each pallet
Steel drums (200 l)	1	3-4

Steel drums (smaller than 200 l)	2	3-4
Fibre drums (200 l)	1	3
Fibre drums (smaller than 200 l)	2	3
Plastic drums (200 l)	1	2
Plastic drums (smaller than 200 l)	2	2
Paper sacks	4-5	3
Plastic sacks	4-5	3
Fibre case containing tins	4-6	3-4
Fibre case containing soft packages (plastic bottles, sachets)	4-6	2
Wooden cases	2-4	3-4

Pesticide shelf-life

The biological efficacy of pesticides gradually decreases with time. The pesticide shelf-life is the period of time that a pesticide can be stored before it deteriorates. Nearly all pesticides have a limited shelf-life. As part of modern pesticide formulation technology, packing methods and storage practice aim to prolong shelf-life as much as possible. Manufacturers indicate the shelf-life of the pesticide on the container, but many pesticides may still be usable long after the indicated shelf-life has expired. Most pesticides have an indicated shelf-life of at least two years from the time of manufacture, but shelf-life will be shortened if pesticides are not stored properly (e.g. if they are stored at high temperatures). Stock turnover organization needs to take into account the time that pesticides may have been in transit between manufacture and reaching the store.

Pesticides in sealed containers may change over time in two main ways:

- The active ingredient may change chemically and break down into products that may no longer have pesticidal properties, thus decreasing the concentration of the original active ingredient.
- The formulation of the pesticide may break down and a precipitate of flakes, crystals or sludges may form, making it impossible to mix or use in sprayers.

An organochlorine such as endosulfan is chemically very stable, but some formulations may break down more rapidly. Organophosphates are much less stable and therefore generally have a shorter shelf-life. Dust and wettable powder formulations tend to break down and cake together, as a result of high temperature, high humidity, strong sunlight or compaction under pressure, more than liquids in sealed containers.

Pesticide ordering and shelf-life

The shelf-life and rate of use must be taken into account when ordering pesticides (Figure 15). Do not order more than one year's requirement. The date of manu-facture and shelf-life should be on the outside of the container. If a larger quantity is ordered than can be used during the period of shelf-life, outdated stocks will accumulate and present disposal problems, as well as financial loss.

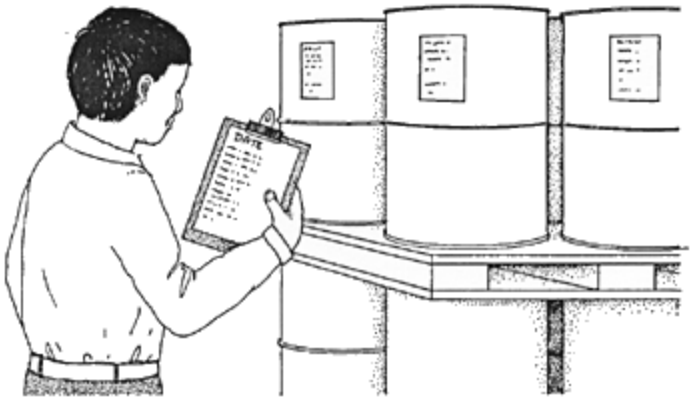


FIGURE 15 - Storekeeper checking dates from labels on containers in a pesticide store

Stock inspection and shelf-life

Stocks in a pesticide store should be inspected regularly for signs of deterioration, such as caking of powders, sedimentation or gelling of liquids and discoloration through oxidation. Shelf-life declines rapidly after containers have been opened and left partially empty. Stock turnover must be organized to ensure that the contents of a container are used as quickly as possible once the container has been opened. Unsealed containers of dusts and wettable powders should not be kept for more than one year.

Containers are not only subject to deterioration caused by external factors (climatic, biological and mechanical), but can also be corroded internally through the action of the pesticides they contain. Emulsifiable concentrate formulations are particularly likely to affect weak spots, especially along seams (Figure 16) or where there are imperfections on the internal coating of the container. Some pesticides increase in acidity during storage and this makes them more likely to corrode containers from within. Discoloration of pesticide is a sign of corrosion of this type and should be looked for during stock inspections.

Outdated pesticide stocks

Often there is no information on shelf-life on the pesticide container label. When this is the case, a two-year shelf-life should be assumed, unless more precise information can be obtained from the manufacturer or distributor at the time of purchase.

Outdated stocks may still be usable if the formulation has not broken down. The only way that this can be verified is by having a sample of the product analysed by the manufacturer or at an independent laboratory and the dose measured accordingly. The date of the test must be attached to the drums after samples have been analysed. Trial and error methods that assess the pesticide's efficacy by using more concentrated doses or higher application rates are not recommended.

Disposal of outdated and unusable pesticides

The main aim of good storekeeping is to minimize the need to dispose of stocks since the disposal of pesticides presents many problems. However, on occasion, it will be necessary to dispose of old stock. Store accounting procedures should allow for old stocks to be written off, that is there should be some system by which unusable pesticides can be removed from the store. Unfortunately the storekeeper does not always have the authority to do this and stock tends to remain on record whether it is usable or not. If there is no system whereby pesticides can be written off and subsequently disposed of, old pesticides soon

present hazards as their containers deteriorate and start to leak. The disposal of unwanted pesticides is considered later on.

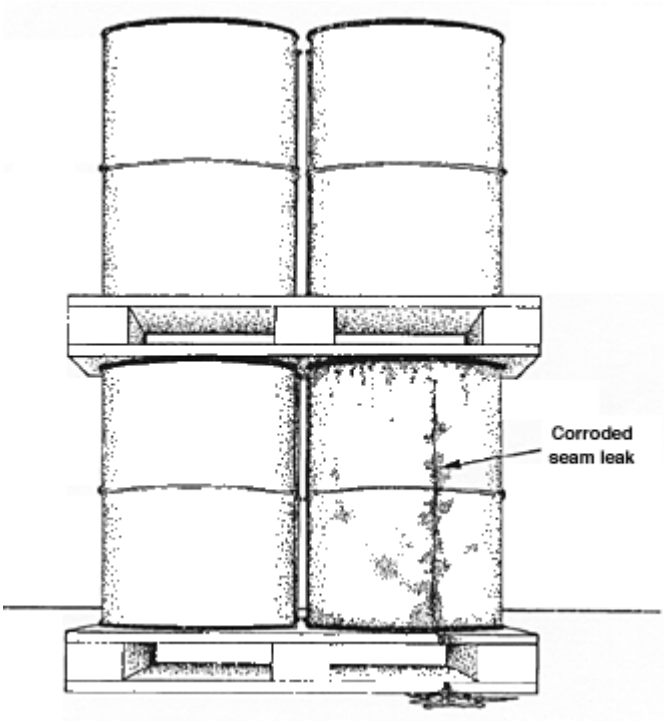


FIGURE 16 - Pesticide container corroded and leaking from a side seam

Pesticide stock planning and recording systems

Pesticide stores should have a proper system of stock planning and should keep records of stocks received, held and issued. No more pesticide should be ordered than is required or than can be stored in an appropriate way. Major problems have been caused where there was no system or where the storekeeper had not been trained in, or failed to use, an existing system. Without a record system, orders for excessive quantities of pesticide can be made and the most recently received stock tends to be issued first because older stock is less accessible or the customer wants "fresh" pesticide.

As pesticides have a limited shelf-life, it is essential that only sufficient pesticide is ordered for requirements and that issues are made on a "first in -first out"basis. If such a procedure is not followed, old, out-of-date stocks of pesticide accumulate in deteriorating containers, particularly in dark recesses of the store.

Not only do these stocks represent a financial loss to the store-owner (government, marketing board, agricultural cooperative, pesticide wholesaler or retailer or individual farmer), but they also constitute a hazard to personnel working in the store and present an environmental problem when they are eventually disposed of. The movement of chemicals into and out of the store must be carefully recorded. This information may also be required for emergency services, such as the fire brigade, in the event of a disaster so that the volume of pesticides involved can be assessed.

Record systems

The record system adopted will depend on the size and function of the store and on the accounting requirements of the store-owner. Records should be kept separate from the pesticide store.

Small store

No elaborate system is required or usually possible at the minimum level of, for example, a small-scale farmer storing only a few pesticides. But even the small-scale farmer should adhere to the following practices, which are essential in all pesticide stores of whatever size:

- The date of purchase or arrival should be written on each container as it is deposited in the store.
- Ensure that all containers have proper labels and that these remain attached to the containers and are clean and readable; labels in poor condition should be replaced.

In addition, the small-scale farmer should keep invoices, delivery notes or receipts obtained in connection with pesticide purchases separate from the store. This will enable the farmer to contact the pesticide supplier in the event of an emergency or if further advice is needed. The farmer should also have a supply of material safety data sheets, which the supplier or manufacturer can provide.

Large store

Any store above the size of a small-scale farmer's will require some sort of formal records system. The system adopted depends on circumstances. Records should be kept separate from the pesticide stock so that they are not destroyed in the event of a major disaster (such as fire, flood, earthquake, hurricane or destruction during civil unrest).

Records may be kept as sheets in a ledger or in card index form. Duplicate records adjacent to the stock itself may also be required, perhaps in simplified form. Again, a supply of material safety data sheets should be requested from the supplier or manufacturer.

Records should be accurate and sufficiently detailed to enable a replacement storekeeper to take over responsibility without needing to refer to the previous storekeeper.

Pesticides have a limited shelf-life, and stock batches bought at different times may vary in formulation and packaging. It is important that a completely separate record be allocated to each consignment of different pesticides as it is received by the store.

The national authority responsible for the procurement of pesticides needs to be regularly updated on stocks kept in various locations in the country and stores should be able to supply this information.

A possible layout for a pesticide store record sheet is given below. The store record sheet allows the progress of each consignment of a particular pesticide to be followed from receipt, through inspections, stocktaking and checking to issues, analysis of stock after the shelf-life has expired and disposal when deterioration has been established.

Well-kept records are the sign of a properly run store and are essential for minimizing wastage of stock or damage caused by accidents. The store supervisor should ensure that there is an adequate system being followed by the storekeeper at all times. The storekeeper should be trained in the use of the records system and must be responsible for its upkeep.

Sample pesticide store stock record sheet

Pesticide group	*Insecticide OP*
Ref. no.	*Inv 29/5[R3]*
Common name	*Chlorpyrifos*

Trade name *Dursban*
Formulation/concentration *% ec, 400 g/litre*
Manufacturer/supplier *Dow Elanco, USA*
Quantity *(agreed issuing quantity/package)* *1 000 2.5-litre plastic containers*
Primary packaging quantity *Four containers of 250 cartons*
Date received *20 December 1994*
Use-by date *1 December 1996*
Notes *(shelf-life; special storage conditions; inspection frequency)* *Two-year shelf-life; keep cartons sealed; inspect every six months; look out for breakdown of plastic containers*

Date	**Quantity issued** *(litres)*	**Balance in stock** *(litres)*	**Notes***(stock inspection: notes on condition etc. storekeeper's initials)*
25 December 1994	*650*	*1 850*	
6 June 1995			*Stock inspected; no damage. MRKL*
10 June 1995	*1 300*	*550*	*Stock check. MRKL*
10 September 1995		*548*	*Stock inspected; two containers leaking; disposed of. MRKL*
30 September 1995	*548*	*nil*	

Record of disposal of outdated stock *Leak absorbed by sawdust and burnt, split containers relocated to store II and contents transferred*

(MRKL are the storekeeper's initials)

Notes on the sample record sheet

Reference number Cross-reference should be made to the invoice or delivery note; location of the pesticide in the store (bin, shelf or row number).

Identification of the pesticide Pesticide group, common and trade names with details of formulation and concentration should all be recorded.

Source of the pesticide Where possible information on primary manufacturer or formulator, as well as local source, should be recorded (with local telephone number where available in case of emergency). Where the pesticide came from should also be recorded since many stocks are shifted around.

Packaging and issuing units These may differ; the pesticide may be in 200-litre metal drums or in 1-litre cans packed in boxes of 20 with sales or issues being made in units of the 1-litre can.

Date received Possibly the most important item of information; it is essential that this should be documented. It must also be recorded on the actual pesticide containers together with the use-by date (Figure 17).

Notes Information should be obtained from the supplier on shelf-life (use-by date), any special storage requirements, particular hazards and other details, which should be incorporated as instructions to the storekeeper on the record form.

Stock operation and management Details of receipts and issues must be meticulously recorded and records of periodic stock inspections should be kept initialled by the inspector. Careful notes should be made on the state of containers and contents at the time of inspection.

Disposal When outdated stock is eventually disposed of it should be recorded, with notes on the method of disposal of the pesticide and its containers, the location of dumps, etc.

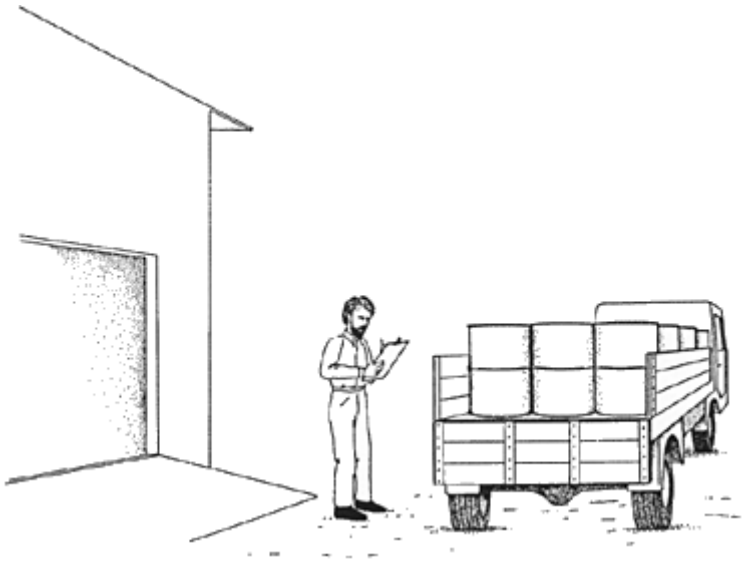


FIGURE 17 - Storekeeper recording date of arrival and inspecting condition of new stocks of pesticides, clipboard in hand

Local transport of pesticides

Severe cases of poisoning have been caused by the transportation of pesticides with other commodities.

Containers of pesticides have leaked during movements, contaminating foodstuffs such as flour and rice packed in sacks and carried in the same truck. People have eaten the food after it has arrived at its destination and have become ill; thousands of deaths have resulted from poisoning in this way. There are several basic points to be remembered:

- Food, animal feed or general consumer goods should not be transported in the same truck as pesticides (Figure 18).
- Open or leaking containers of pesticides should never be transported.
- If pesticide containers must be transported with other goods, they must be separated in sealed partitions and securely fixed with straps or rope.
- Pesticide containers should be loaded in such a way that they will not be damaged during transport, that their labels will not be rubbed off and that they will not shift and fall off the truck on rough road surfaces (the load must be securely fixed).
- The truck driver or railway officials should be informed that the load consists of toxic pesticides and should be given instructions on what action to take in the event of an emergency (crash, fire, spillage). Material safety data sheets should be provided if possible.

- The pesticide load should be checked at intervals during transportation and any leakage, spills or other contamination should be cleaned up immediately. In the event of leakage while the means of transport is moving, the vehicle should be brought to a halt immediately to stop the leakage and the leaked product should be cleaned up.
- With a major spill, people should be kept away and the spill covered with earth, sand, etc. (Figure 19); no attempt should be made to wash away the spill with water or other substances.
- The truck, including tarpaulins and other goods, should be checked for evidence of spills or leaks after the pesticides have been unloaded, and then decontaminated of pesticide before it next departs.
- Pesticide containers should be loaded and unloaded carefully (Figure 20); most leaks from containers in storage are caused by damage during transportation and handling.
- Newly arrived consignments should be checked for leaks and loose lids, and repacked immediately if necessary. Replace torn or unreadable labels. A supply of empty new containers should be available for repacking from damaged ones.

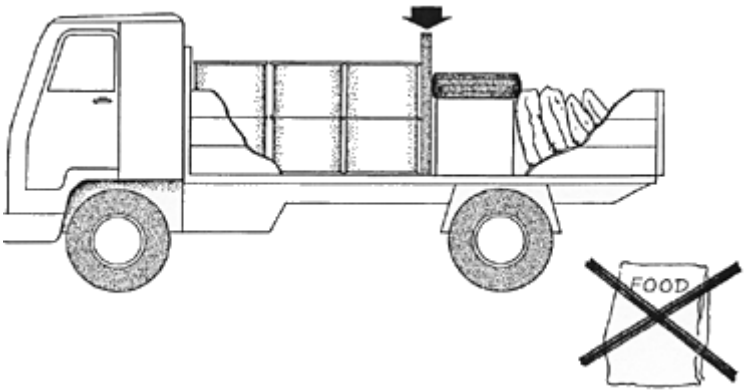


FIGURE 18 - Local transport of pesticide on a goods vehicle - other materials are partitioned off but food must not be carried

FIGURE 19 - Spill, caused by a pesticide drum falling off a vehicle, being covered by soil - people are kept away from the spill

FIGURE 20 - Careful unloading of pesticides from a delivery vehicle to avoid leaks resulting from damage to containers;
the storekeeper is examining the delivery note

Spills, leaks and disposal of containers and chemicals

Pesticides are biologically active materials and potentially hazardous to human health and the environment. Complete decontamination and effective disposal are often very difficult to achieve. One of the most important objectives of good store management is therefore to minimize the occurrence of leaks, spills and outdated stock.

Spills

There will occasionally be spills, even in the best run stores, especially where concentrates are repacked and transferred into other containers. Spills must be cleaned up immediately. Always have two people working when handling severe spills.

Untreated spills may corrode other containers, become trodden in and contaminate store personnel and may produce toxic or inflammable fumes. If not removed quickly, the spilled chemicals may be absorbed by the floor. Floors therefore need to be made of impermeable (sealed) concrete or other non-absorbent material - removing the contaminated part and replacing it may be the only way to decontaminate absorbent brick, earth or wooden floors.

Liquid spills

The spill should not be hosed down as this merely disperses the pesticide over a wider area.

A supply of absorbent sawdust, sand or dry soil should be kept in a container in the store.

Nitrile rubber protective gloves and face-mask should be worn.

Sawdust, sand or dry soil should be scattered over the area of the spill and left for a few minutes to soak up the chemical.

The sawdust, sand or dry soil containing absorbed spilled chemical should be swept or shovelled up and placed in a marked container for disposal (Figure 21).

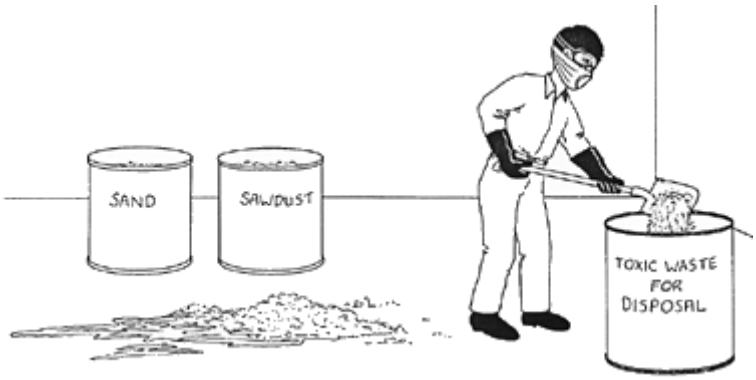


FIGURE 21 - Spill soaked up by sand or sawdust being carefully swept up by the storekeeper and placed in a container to be collected and taken for central disposal by the national authority

After sweeping, 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. Excess soapy water should be removed with a rough floor cloth and not hosed down.

Solid spills

Dusts, wettable powders or granules can create dust when swept up without the use of an absorbent material. A supply of absorbent sawdust, sand or dry soil should be kept in a container in the store where they can easily be reached for use in an emergency .

Nitrile rubber protective gloves and face-mask should be worn.

The sawdust, sand or dry 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 shovelled up carefully and placed in a marked container for disposal (Figure 21).

After sweeping, 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. Excess soapy water should be removed with a rough floor cloth and not hosed down.

Leaks

Leakage from containers is a major problem in the storage and transport of pesticides (Figure 22). The main cause is rough handling which dents drums, weakens or splits seams and weakens closures (lids, caps and stoppers). Other causes of mechanical damage are puncturing or abrasion during transport when packages and containers rub against one another or against the sides of the truck travelling over uneven surfaces and rough roads.

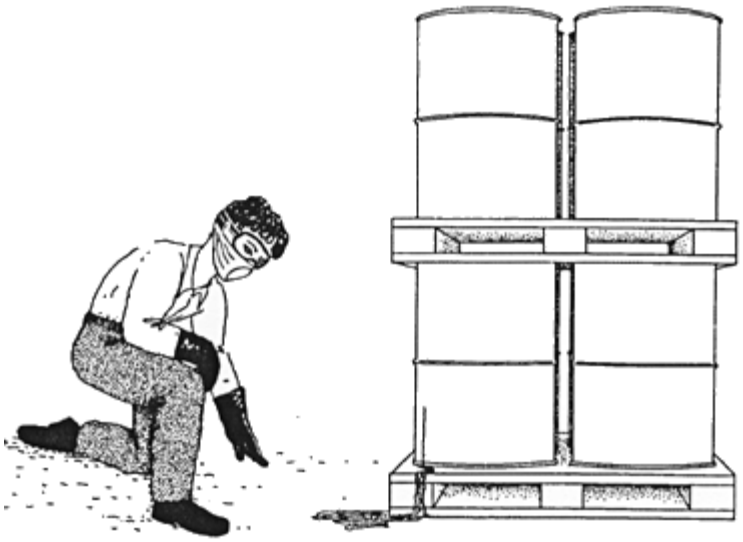


FIGURE 22 - Storekeeper inspecting a leak from a pesticide container

Leaks also result from corrosion of the container, which may be accelerated by mechanical damage (dents may rupture drum linings, for example). Corrosion may start internally, the pesticide itself or its breakdown products being the primary cause. Alternatively, corrosion may begin externally, as a result of rusting in damp storage conditions or contamination from pesticide leaking from nearby containers. Many emulsifiable concentrate (ec) formulations are very corrosive. Some, including monocrotophos, dicrotophos, dichlorvos and phosphamidon are incompatible with steel, so they should be packed in plastic or aluminium containers or in steel containers lined with inner coatings. Some pesticides are dissolved in organic solvents that cannot always be packed in plastic drums.

Containers may leak for other reasons; for example, strong sunlight can degrade some plastic containers, including bottles and plastic sacks. Rodents may damage paper, board or fibre containers. Termites may attack paper and card.

Stores should be inspected regularly, at least every two months. Old, rotting and leaking containers are extremely difficult to move safely, so any leaking containers should be dealt with immediately.

Usually, the only way to deal with a leak is to repack the material in a sound container. New containers are preferable, if available, but old containers of various types and sizes may be used for this purpose (old containers are also useful for temporarily storing the products of spills). They must have been thoroughly decontaminated (see next section) and their old labels completely removed.

Pesticides should be repacked in containers made of the same materials as the original containers as some chemicals are not compatible with different materials. Ideally a drum that contained the same product should be used. If unavailable, the container must have been properly cleaned of previous contents to avoid cross-contamination. New labels must be written out immediately with all the information on the old label and fastened securely to the new container. Write the date of repacking (and the date of the original receipt) on the replacement container and ensure that the repacked material is used first.

Disposal

Disposing of pesticide containers

Many accidents have been caused by empty pesticide containers being used to store water and food. An empty pesticide container can never be cleaned completely of pesticide and should be disposed of in a way that ensures it cannot be used for other purposes. It is, however, wise to retain samples of various

types of container, which have been carefully cleaned, in the pesticide store for use in repacking the contents of damaged containers and storing cleaned up leaks and spills prior to final disposal.

Empty containers awaiting disposal should be stored in a special, secure area in the pesticide store to ensure that they are not stolen and used for other purposes.

Empty containers should always be cleaned out, as far as is practicable, before disposal to minimize both hazard and waste of residual pesticide. Containers that have contained ec or wettable powder (wp) formulations should be rinsed with water several times and the rinsings added to the spray tank before it is topped up to the required volume. Following this, containers can be washed out with a mixture of water, detergent and caustic soda (Figure 23). Containers of liquid formulations may be cleaned with kerosene (paraffin) or diesel fuel and the washings (small quantities of about 5 litres) collected for sending later to a central location for disposal by the national authority in a safe and environmentally sound manner.

FIGURE 23 - Decontamination of a pesticide container - the inside and outside are being cleaned with detergent and water -
highly contaminated rinsings should be saved for disposal with other major toxic waste

As long as they are not heavily contamined paper, cardboard and fibreboard containers should be burnt on a fire in the open (Figure 24). However, cartons that have contained phenoxy acid herbicides should not be burnt because the combustion products can damage crops at long distances. Highly contaminated cardboard, paper and jute materials should be collected and sent to the central disposal centres along with other toxic waste.

FIGURE 24 - Disposal of lightly contaminated cardboard pesticide container on a fire, ensuring that fumes travel away from personnel

Containers rendered unusable, the products of decontamination procedures, leaks and spills, and container rinsings (where these have not been added to the spray tank) should all be collected for sending later to a central location for disposal by the national authority.

Glass containers should be smashed and steel drums and metal and plastic containers punctured (Figure 25) and crushed (do not puncture aerosol containers) before being sent to a central location for disposal by the national authority.

FIGURE 25 - Metal container being crushed son that it cannot be reused - it will be collected for central disposal by the national authority

Disposing of unwanted pesticides

Using pesticides for their intended purposes according to label instructions is the most satisfactory means of disposing of them. For this reason, no more than one year's requirement of pesticides should be ordered and stored, so that none will remain at the end of the product's shelf-life of two years. Only as much pesticide as can be used in a day's operations should be withdrawn from the store and only as much as will go into the sprayer tank should be mixed.

Occasions will arise when it will be necessary to dispose of pesticide concentrates, either because the stock is outdated and has been found to be unusable or because the product is no longer registered for the original purpose. Where very large quantities are to be disposed of, professional advice must be sought from the suppliers and national authority.

If only a few kilograms or litres of pesticide are involved, they should be collected for sending later to a central location for disposal by the national authority. Larger quantities of pesticides are best disposed of by burning in a special incinerator (at 1 200°C) - this does not mean that it would be safe to burn them at a lower temperature on a fire. Incineration requires special equipment with provision for "scrubbing" the combustion products, but this is beyond the capacity of pesticide storekeepers and should be referred to the relevant national authority.

Other means of disposal are to return the pesticide to the supplier or pass it on to a specialist disposal agent elected by the national authority.

Returning the pesticide to the supplier or to the national authority is the safest means of disposal. Disposal involves chemical methods such as alkaline and acid hydrolysis. Oxidation, reduction and spraying on to the ground or allowing to escape into the atmosphere may also be employed, but require specialist skills. The end product in most cases is still toxic. Storekeepers should not become directly involved with pesticide disposal and should refer to the relevant national authority.

Decontamination

Personnel

Pesticides coming into contact with the skin can rapidly enter the body. Successful decontamination of body surfaces requires:

- prompt action and rapid application of plenty of soap and water;
- extremely thorough washing.

Anyone contaminated with pesticide should strip off their clothing and quickly and thoroughly scrub the affected part of their body with soap and water. This should be followed by careful rinsing and towelling dry (Figure 26).

FIGURE 26 - Storekeeper decontaminating himself by washing thoroughly with soap and water - his protective clothing, washed separately, is hanging out to dry in full sunshine

Protective clothing

Contaminated protective clothing should be thoroughly washed using industrial grade detergent followed by several rinsings. Protective clothing should not be washed with the family wash. Gloves should be worn when washing protective clothing. Hot water should be used when available. Washed clothes should be hung to dry in full sunshine.

Where there is a large patch of fabric that has been contaminated by toxic concentrates and replacement clothing is available, it is best to destroy the affected clothing by burning.

Stores and vehicles

When dealing with leaks and spills, water, soap or detergent are usually the most readily available materials for decontamination. However, other chemicals sold for domestic or common commercial purposes may be useful too.

Organophosphorus compounds can be treated by sodium hypochlorite (bleach) and sodium carbonate (washing soda), which are useful for decontamination and can be applied following initial scrubbing with soap and water.

Organochlorine compounds are persistent chemicals and household ammonia and washing soda can be used, but the main method is to scrub with water and detergent.
Carbamates should be scrubbed with washing soda or strong soap.

Transport vehicles should be decontaminated thoroughly as soon as spills or leaks are seen, otherwise there is a danger that when used subsequently for other goods, including foodstuffs, the goods could become contaminated (Figure 27). Spills are cleaned up in the same way that they are in stores. The contaminated washings from the vehicle should be absorbed by sawdust, sand or dry soil and placed in a container for collection and central disposal by the national authority.

FIGURE 27 - Scrubbing the back of a delivery truck using detergent and water to decontaminate it of pesticides

Major emergencies

Major emergencies are a far greater risk for pesticide stores than they are elsewhere.

Fire

The primary objective in the design and management of pesticide stores is to reduce the risk of fire. Prevention is better than cure!

Pesticides, especially those formulated as liquids, present major fire hazards because the solvents used in formulations (oils and petroleum distillates) have low flashpoints and may be readily vaporized at normal temperatures. In poorly ventilated stores heavy vapours may accumulate near the floor if drums are left open or if leaks and spills are not cleared up. An electrical spark, naked flame or even the sun's rays concentrated by a glass container may cause an explosion followed by the spread of fire.

Some wettable powders are suspected of starting fires through spontaneous combustion, while sodium chlorate (used as a herbicide, defoliant, desiccant and soil sterilant) is a powerful oxidizing agent that easily catches fire and should only be supplied with a fire suppressant in the formulation (once sodium chlorate containers have been opened their entire contents should be used immediately).

The outside of pesticide stores should bear prominently displayed warning notices stating "Danger pesticides: authorized persons only" and "No smoking: no naked flame" as well as symbols. These rules should be strictly followed.

Fire extinguishers (powder or carbon dioxide, not water) should be available in the store and should be regularly checked. Static or running water (required, together with soap, for decontamination purposes anyway) should also be available and buckets of sand or earth (also required for absorbing any liquid pesticide spills or leaks) are useful for putting out small fires (Figure 28).

FIGURE 28 - Extinguishing a small fire in a pesticide store using shovefuls of sand or earth from a container

The local fire brigade should be informed of the store's existence and the hazards involved. It is very useful to place a notice on the outside of the store giving names and addresses of those responsible for the store (including key holders) who can be contacted in an emergency.

In the event of a fire it is essential to try to contain the pesticides that leak from burning and exploding containers in the store. Hence the need for bunding of some kind to be provided when the store is built; bunds also prevent the water used to fight the fire, which inevitably becomes contaminated with pesticides, from contaminating the neighbourhood and thus the environment generally.

Contamination of the environment from combustion products such as smoke and fumes cannot be prevented. A light roof designed to collapse easily in a fire will at least permit the fumes to be carried upwards away from the fire-fighters (Figure 29).

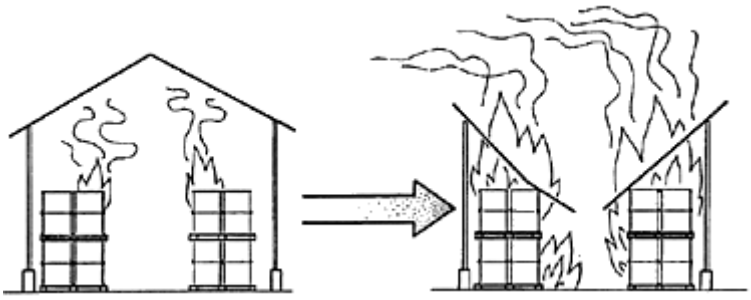


FIGURE 29 - Pesticide store in flames - the light roof has collapsed thus preventing an explosion

Fires in pesticide stores that contain organophosphorus compounds and carbamates can be extremely dangerous to fire-fighters, who should never go downwind of the fire and should always wear breathing apparatus.

Solid water streams from fire-fighting hoses should be avoided since they can disperse the pesticide, especially powder formulations, over a wide area. Care should also be taken to avoid dragging fire hoses

through contaminated water.
Protective clothing and equipment used by fire-fighters should be thoroughly decontaminated after the fire.

Flooding

Flooding during seasonal rains is a common event in tropical countries. Flooded pesticide stores are subject to special hazards.

Cardboard or paper containers in which many pesticides are packed lose strength and may leak or burst open when wet. Other containers, especially partially empty drums of liquid, may be swept away with a flood. Environmental contamination over a wide area may result from either of these events; water supplies may become polluted and pesticide containers may present a hazard to people who find them.

Destruction

Dangers from fire, flooding and destruction during civil disturbances emphasize the value of keeping records of stocks in a place where they will be safe in an emergency. Records of the quantities and types of pesticide involved prove invaluable in subsequent efforts to clean up, trace missing containers and assess the environmental risk and financial loss caused by the emergency.

Personal safety and protective clothing

When working with pesticides, do not eat, drink or smoke. Wash hands and face thoroughly with soap and water before smoking or eating. Also wash your hands before using the toilet. Some form of protective clothing is required when handling and transferring pesticides in stores. In warm, humid tropical climates, wearing additional protective clothing may be uncomfortable. Ideally, therefore, only pesticide types and formulations which do not require additional protective clothing should be stored. This is unlikely to be possible in most cases however.

General body protection

The garments worn should have long sleeves and covering for the lower body and legs. Footwear (boots or shoes) and some kind of head covering should also be worn. Many kinds of normal clothing in tropical and subtropical countries provide good general body protection in any case, but work clothing should be in a good state of repair and should not have tears or worn areas through which pesticides can enter and contaminate the skin. Work clothing, including footwear, must be washed in water with soap or other detergent after each dayís use, separately from other clothing.

Hand protection

When pouring and otherwise transferring pesticides from one container to another, chemical-resistant gloves should be worn (Figure 30). They must fit the hands comfortably and be flexible enough to grip pesticide containers firmly. They must be long enough at least to cover the wrists.

FIGURE 30 - Storekeeper wearing mask, eye protection, gloves and apron over shirt and trousers to protect himself from splashes while transferring pesticide concentrate

Gloves made of nitrile rubber or neoprene offer good protection against a wide range of pesticide products, especially those dissolved or suspended in water, granules or dusts. Gloves made of natural rubber do not provide sufficient protection against products such as emulsifiable concentrates and ultra-low-volume pesticides.

The outside of gloves should be rinsed with water before removal and the gloves should be washed inside and out and allowed to dry after each dayís use. They should be examined for signs of wear and tear, particularly between the fingers.

Footwear

Calf-length rubber boots give protection against a wide range of dilute pesticide products. Leather footwear is unsuitable because it absorbs some pesticide products and cannot be decontaminated. Trousers should be worn outside the boots so that spills and splashes do not fall into them.

Eye protection

Goggles or face shields are used to protect the eyes from splashes (Figure 30) and when transferring dusts. Face shields are cooler to wear in hot, humid climates and do not mist over as easily as goggles. Although they provide less satisfactory eye protection, the use of safety spectacles is preferable to no protection.

Wash after use to remove any contamination. An eyewash set should also be available.

Protection against inhalation

There should be a sufficient stock of lightweight disposable masks that cover the mouth and nose when handling dusts. The masks must be discarded after use. Vapour masks or half-face respirators with organic vapour cartridges should also be available.

Apron covering

Aprons are useful additional protective items for loading operations, handling concentrated formulations and cleaning out containers before disposal. Aprons made of PVC, nitrile rubber or neoprene, or disposable ones made of polyethylene materials, provide adequate additional protection for operations of this kind. The apron should cover the front of the body up to the neck and down to the knees. As with other protective equipment, aprons must be washed after use and inspected regularly for signs of damage.

If items of protective clothing are not available, the national authority responsible for supplying or distributing pesticides should ensure that they are provided. Donors and suppliers of pesticides should be asked to provide them.

Annexes

Essential equipment within a pesticide store

Thick polyethylene sheeting on floor (if surface is not concrete or otherwise impermeable)
Floor dunnage (bricks, timber)
Wooden pallets
Ramps at entrance to contain leakage
Entrance door with lock to prevent unauthorized entry
Bars across windows and ventilators to prevent unauthorized entry
Container of absorbent sand, sawdust or dry soil
Shovel
Long-handled brush with stiff bristles
Short-handled brush and pan
Water supply, or container of water, with soap
Detergent solution
Drum spanners
Metal funnels
Fire-fighting equipment:
fire extinguisher
fireproof blanket
Protective clothing:
helmet or cloth cap
safety spectacles, goggles or face shield (attached to helmet)
dust or light fume masks
emergency vapour masks or half-face respirators with organic vapour cartridges
nitrile rubber or neoprene gloves or gauntlets
overalls
nitrile rubber or neoprene aprons
strong rubber or neoprene boots
Empty pesticide containers (preferably salvage drums that can contain a whole 200-litre drum)
Empty bags to repack heavily damaged or leaking containers
Self-adhesive warning labels for marking drums
Emergency first aid equipment:

first aid box
stretcher and blanket
eyewash set

Stock record sheets

Routine pesticide store management procedures

1. The storekeeper should put on essential protective clothing (overalls and boots) upon arrival at the pesticide store.
2. There should be a quick daily inspection of drums and containers to ensure that there have been no overnight spills or leaks.
3. Spilled and leaked pesticide must be cleaned up immediately, using the methods described in section "Spills, leaks and disposal of containers and chemicals".
4. Drums and containers should be thoroughly inspected monthly for leaking seals, split seams and corrosion.
5. Leaking or old drums should be removed and their contents transferred to empty containers. Appropriate protective clothing should be worn and precautions taken as described in section "Personal safety and protective clothing". Replacement containers should be sealed and relabelled.
6. Transfer of chemicals to new containers should be recorded on the stock record sheet.
7. Dates on labels of containers in the store should be checked monthly and outdated stock separated for disposal. Any labels in poor condition should be replaced.

Arrival of a consignment of pesticides at the store:

1. The back of the transport vehicle should be checked for spills and the containers for leaks or broken seals; the vehicle should be decontaminated of any spills. Chemicals from containers with leaks or split seams should be transferred to empty containers in good condition and relabelled.
2. Pesticide containers should be carefully unloaded from the delivery vehicle. The delivery note should be examined and check-list of chemicals arriving at the store should be prepared on a stock record sheet.
3. Containers of chemicals placed in the store should be set on floor dunnage and stacked using wooden pallets as necessary.
4. The location of chemical containers in the store should be recorded on the stock record list.

Taking pesticides from the store for pest control purposes

1. The condition of the transport vehicle should be checked before placing containers of pesticides in it. It should also be ensured that no foodstuffs are to be carried on the same vehicle.
2. The removal of pesticides from the store should be recorded on the stock record sheet.
3. The stock first deposited in the store should be the first to be taken out.
4. Pesticide containers should be carefully loaded on to the despatch vehicle and the driver provided with a delivery note.

Ten rules for proper pesticide storage and stock management

1. Pesticide stores should not be located in or near densely populated urban areas or near water bodies.
2. The storage capacity (total storage surface) should be sufficient to store the total stock of pesticides at any time.

3. Each store should have at least the following:
    - sufficient ventilation openings to avoid unnecessarily high temperatures;
    - floors made of, or covered by, impermeable concrete or cement (as a temporary measure, floors may be covered by a large and thick polyethylene sheet);
    - ramps at entrances to contain any major leakage within the store;
    - doors that are lockable and bars across ventilation holes and windows to prevent unauthorized entry.
4. The floor of the store should have a layout of separate blocks with aisles between them. Ideally the outline of the blocks should be painted on the floor. Each block should contain only one product. There should be sufficient space between blocks to move containers freely, enable the inspection of containers and treat leakages. Drums should be stacked in such a way that each can be inspected from the aisles between the blocks. Drums and bags should be stored on pallets. The number of containers stacked on top of each other should not exceed the stacking recommendations for the type of container concerned. Overstacking may lead to rupture of containers lower down and reduces access to containers.
5. Pesticide stores should only contain pesticides. All other goods or objects should be removed.
6. Obsolete pesticides should be separated from operational stocks.
7. Each store should have the following for dealing with emergencies:
    - a few bags of sawdust and/or sand to absorb leaked or spilled pesticides;
    - a number of empty containers (preferably salvage drums that can contain a whole 200-litre drum) and empty bags to repack heavily damaged or leaking containers;
    - spade and brush;
    - fire extinguisher;
    - protective gear for staff to enable them to deal with emergencies (nitrile rubber or neoprene gloves, rubber boots, overalls, goggles, vapour masks or half-face respirators with organic vapour cartridges)
    - water supply from a tap, or a container of water, to wash hands and face if these become contaminated;
    - eyewash set.
8. The contents of leaking or heavily damaged containers should be repacked in appropriate replacement containers. Repacked pesticides should be labeled immediately. Stores should be inspected regularly. Any leakage or contamination should be cleaned up immediately.
9. Storekeepers should keep a record of the stocks in their custody and a separate record of stocks in the country should be kept centrally. Recorded data should include: for incoming pesticides, the arrival date, formulation, quantity, unit size, date of manufacture, supplier and origin; for outgoing pesticides, the date, formulation, quantity, unit size and destination. Records should be updated regularly.
10. A "first in - first out"principle should be applied consistently. In other words, always finish old consignments before using newly arrived consignments.

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