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# PEST MANAGEMENT GUIDELINES OF THE AGENCY FOR INTERNATIONAL DEVELOPMENT

**Washington, D.C. 20523**

**Summer 1991**

**PREFACE**

These pest management guidelines were prepared in response to the need for a more uniform and informed approach to pest management activities conducted and/or supported by the Agency for International Development and its missions abroad. The information herein was gathered and compiled by Drs. William Overholt, Allan Showler, and Benjamin Waite (contracted as plant protection specialists to work in A.I.D.'s Office of Agriculture, Bureau for Science and Technology), and Dr. Hiram Larew in A.I.D.'s Science Advisors Office. Reviews were provided by agricultural, policy, and environmental officers within A.I.D./Washington, various USAID Missions and the U.S. Environmental Protection Agency.

# FIGURES AND TABLES

FIGURES



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## ACRONYMS

| | |
|---|---|
| ABS | Annual Budget Submission |
| AFR | Africa Bureau (AID/W) |
| A.I.D.U.S. | Agency for International Development |
| AID/W | A.I.D. Headquarters in Washington, D.C. |
| ANE | Asia and Near East Bureau (now split into ENE and APRE) |
| AP | Action Plan |
| APHIS | Animal and Plant Health Inspection Service (USDA) |
| APRE | Asia/Pacific and Private Enterprise Bureau (AID/W) |
| BEC | Bureau Environmental Coordinator |
| BHC | Benzene Hexachloride |
| CDSS | Country Development Strategy Statement |
| CEQ | Council on Environmental Quality |
| CFR | U.S. Code of Federal Regulations |
| CP | Congressional Presentation |
| CPSS | Central Program Strategy Statement |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| ENE | Europe and Near East Bureau (AID/W) |
| EPA | U.S. Environmental Protection Agency (also, USEPA) |
| FAO | Food and Agriculture Organization of the United Nations |
| FDA | Food and Drug Administration (U.S. Dept. Health) |
| FFDCA | Federal Food, Drug and Cosmetic Act |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| FODAG | Office of the U.S. Permanent Representative to the United Nations Food and Agriculture Organization (A.I.D. Liaison Office with FAO in Rome) |
| IEE | Initial Environmental Examination |

| | |
|---|---|
| IPC | Integrated Pest Control (European terminology for IPM) |
| IPM | Integrated Pest Management |
| LAC | Latin America and Caribbean Bureau (AID/W) |
| $LD_{50}$ | Lethal dose for 50% of the population. The lower the $LD_{50}$, the more toxic the pesticide. |
| NEPA | National Environmental Policy Act |
| NGO | Non-Governmental Organization |
| OECD | Organization for Economic Cooperation and Development |
| OFDA | Office of U.S. Foreign Disaster Assistance (AID/W) |
| PEA | Programmatic Environmental Assessment |
| PID | Project Identification Document |
| PP | Project Paper |
| PPQ | Plant Protection and Quarantine (division of APHIS) |
| PROAG | Project Agreement |
| RD/AGR | Bureau for Research and Development, Office of Agriculture (AID/W) |
| REDSO | Regional Economic Development Services Office |
| ROCAP | Regional Office for Central American Programs (Eastern and Southern Africa, Western and Central Africa) |
| TDY | Temporary Duty |
| ULV | Ultra Low Volume |
| USAID | A.I.D. Country Missions |
| USDA | U.S. Department of Agriculture |
| USEC | United States Economic Commission |
| USEPA | U.S. Environmental Protection Agency |
| USG | United States Government |
| WHO | World Health Organization |

# EXECUTIVE SUMMARY

Many A.I.D. projects deal with pest problems that can reduce the quality and yield of crops and affect livestock and humans. The purpose of the Pest Management Guidelines is to provide information to A.I.D. personnel on the design and implementation of environmentally and economically sound pest and pesticide management activities.

The Guidelines should be consulted during project development and implementation. They clarify numerous A.I.D. policies and procedures, present pest and pesticide management issues, and identify techniques available to manage pests and pesticides. **These Guidelines are not meant to replace or revise the detail and scope of A.I.D.'s existing policies and procedures.**

The goal of A.I.D.'s environmental and natural resources policy is to assist developing countries to conserve and protect their environment and natural resources, and to encourage long-term economic growth by managing resources for sustainable yields. In attempting to support sustained productivity while protecting the environment, a systematic approach to pest control is essential.

Chapter I provides a synopsis of A.I.D.'s policy as it relates to pest management activities in developing countries. A.I.D.'s policy encourages the incorporation of mitigative measures, such as Integrated Pest Management (IPM) in project design prior to project authorization and implementation. In implementing IPM tactics, A.I.D. policy emphasizes using minimal amounts of carefully selected pesticides, and, where possible, nonchemical control tactics, developing infrastructure for pest and pesticide management, communicating U.S. policy to other nations, and supporting host country efforts to study improved pest management methods. A.I.D. policy supports the creation of host country laws and regulations that maximize pesticide efficacy while minimizing adverse environmental impacts.

Chapter II describes three general approaches to pest management: exclusion, eradication, and management of established pests. There are many available tactics that can be incorporated into IPM strategies, including biological, cultural, physical/mechanical, and chemical methods.

Chapter III focusses on procedures to ensure that potential environmental consequences of A.I.D.-financed activities are identified and considered by A.I.D. and the host country prior to project or activity implementation. The procedures that guide this policy are in 22 CFR Part 216. Section 117 (c) of the Foreign Assistance Act and Section 533 (g) of the 1991 Appropriation Act requires that A.I.D. review its project, programs, and activities in accordance with 22 CFR 216 which includes instructions for examining A.I.D. projects that involve the use or procurement (includes procurement or use of equipment and technical assistance in connection with pesticide use, storage, transport, and disposal) of pesticides. **Project officers must always consult and comply with 22 CFR Part 216 during the design and implementation of activities involving the use or procurement of pesticides.**

Where pesticide procurement or use is planned, the environmental review process must address a range of concerns, including USEPA registration status, how the pesticide can be used as part of an IPM program, method(s) of application, acute and long-term toxicological hazards and measures to minimize them, nontarget effects, availability of alternative control methods, host country pesticide and environmental regulations, training of pesticide users, and provisions for monitoring the use and effectiveness of the pesticide.

A.I.D. environmental staff include Mission and Regional Office environmental officers, Bureau environmental officers, and the Agency Environmental Coordinator. Each plays a role in A.I.D. environmental concerns, and should be consulted as appropriate.

Chapter IV discusses how pest management concerns fit into project design and briefly describes the A.I.D. documents required. An integrated approach to pest management often involves research, training, and evaluation, all of which require planning and budgeting. A.I.D. officers who design and implement projects must consult 22 CFR Part 216. The recipient country should be involved in project planning.

Chapter V indicates that there are a wide variety of pesticides which can be classified into different groups using various criteria, including target organism(s), chemistry, formulations, and toxicity. Chapter V also discusses testing procedures for persons occupationally exposed to organophosphate and carbamate pesticides by monitoring the level of the enzyme acetylcholinesterase in the blood. Pesticide regulation in developing countries is an important element of pest and pesticide management. The principal method for controlling the types of pesticides available in a country is by regulating importation, manufacture, and sale through a mandatory registration process and by enacting legislation for in-country manufacturing and formulation.

Public safety and awareness regarding pesticide use is very important. Chapter V provides general recommendations for handling pesticides during application, storage, transport, and disposal. Preliminary guidelines for accidental spills are also given.

Under certain conditions, many pest species can multiply rapidly, producing a plague that can overwhelm control efforts. Outbreaks of desert locusts in Africa and Asia illustrate this phenomenon. Also, when a pest is introduced into an area of the world where it did not formerly exist, the lack of natural defenses may result in potentially devastating plague conditions, as in the case of the screwworm fly in North Africa (introduced from South America). In such situations, emergency operations are often necessary to circumvent massive pest-related damage.

Chapter VI provides guidelines for A.I.D. action in pest emergencies and disasters. Formulating an appropriate A.I.D. response requires a clarification of whether the situation is an "emergency" or a "disaster." In emergency (and non-emergency) situations, A.I.D. Bureaus and Missions may provide support for bilateral or regional pest management programs. Under the authority of A.I.D. Handbook 8, the Office of U.S. Foreign Disaster Assistance (OFDA) will provide funds when a disaster is declared by the U.S. Ambassador. Because emergency and disaster assistance frequently involves the procurement and use of pesticides, A.I.D. requires that such assistance adhere to 22 CFR Part 216 in the choice, use, and handling of the pesticides.

Since prevention is the ultimate goal, A.I.D. should encourage host countries to conduct systematic pest monitoring to forecast impending pest emergencies and disasters.

# CHAPTER I
# PEST MANAGEMENT POLICY OF A.I.D.

## INTRODUCTION

The Pest Management Guidelines document is based on the pest management policy developed by the Agency for International Development (A.I.D.) over the past several years. The guidelines document does not propose new A.I.D. policies pertaining to pest management methods, and it shall not be used to replace, revise, or clarify the detail and scope of A.I.D.'s 1988 Policy Paper on Environment and Natural Resources, its 1978 Policy on Pesticide Support, its 1980 Environmental Regulations in Title 22 of the U.S. Code of Federal Regulations, Part 216 (22 CFR 216), or the decisions of the Bureau and Agency Environmental Coordinators. This chapter summarizes A.I.D. policy relating to pest management to provide perspective and context to subsequent chapters.

The term "pesticide" as used in this document includes any artificial or natural substance used to kill or incapacitate any pest. It is a general term that includes herbicides, insecticides, nematicides, fungicides, antibiotics, rodenticides, plant growth regulators, etc.

The nucleus of A.I.D.'s environmental and natural resources policy resides in the concept of attaining sustained economic and social progress by environmental and natural resources conservation, protection, and management. The primary goal of this policy is to "help developing countries to conserve and protect their environment and natural resources, and to promote long-term economic growth by managing exploited resources for sustainable yields" (A.I.D., 1988).

Population increases in developing countries, a shortage of arable land, and greater food production needs have resulted in the intensification of agriculture and the use of modern technology to increase yields and improve crop quality. Some practices, including continuous cropping, monoculture, and reliance on fertilizers, irrigation, and high-yielding varieties, may aggravate pest problems. The Food and Agriculture Organization (FAO) of the United Nations estimates that about one-third of the world's food crops are lost to pests during production, harvest, and storage. Unless food commodities are protected from pests (e.g., weeds, insects, nematodes, pathogens, and vertebrates), potential gains sought through high-input farming can be offset.

Reliance on pesticides to reduce pest-related crop injury, as well as improper pesticide application procedures, can result in undesirable conditions. These include soil and water contamination, human health risks, pest resistance, destruction of non-target organisms, secondary pest problems, unacceptable toxic residues on agricultural products, and unnecessary financial burdens. A systematic approach to pest control is fundamental in striving to "support activities specifically designed to achieve sustained natural resource productivity and management while protecting or enhancing the environment" (A.I.D., 1988). Integrated pest management--a strategy that aims at maintaining pest populations below economically damaging levels and reducing the use of toxic chemicals--offers ways to achieve effective long-term pest control while mitigating hazards to humans and the environment.

Since the early 1950's, A.I.D. and its predecessor agencies have provided pest management assistance to developing countries for three basic purposes:

1.To protect human health, mainly by controlling vectors of diseases;

2.To protect food crops at both the pre-harvest and post-harvest stages; and

3.To protect livestock from direct pest injury and from transmission of disease agents (A.I.D., 1978).

In 1971, the Agency began to direct pest management activities toward integrated pest management (IPM). In 1976, A.I.D. adopted its first environmental procedures, 22 CFR Part 216 (also known as Regulation 16). This regulation, which was revised in 1980, requires a careful integration of environmental consequences into one decision-making process for A.I.D. projects, programs, and activities. This allows mitigative measures, such as IPM, to be incorporated into project design prior to authorization and implementation. Still, it is important to recognize that:

oDeveloping countries do not have adequate infrastructure to regulate, store, handle, distribute, monitor, apply, and dispose of pesticides;

oMany developing countries directly or indirectly subsidize chemical pesticide use, which often leads to overuse and discourages the application of alternative pest management techniques. Similarly, government controls on the price of other agricultural inputs, such as fertilizers and water, and on agricultural products may discourage the use of alternate pest control methods;

oDeveloping countries will continue to use pesticides, and strictly controlled A.I.D.-financed pesticides represent only a small fraction of the total;

oIt will be necessary to continue pesticide use in malaria and other vector-borne disease control programs; and

oGreater donor coordination is needed to provide adequate pest management materials and training to developing countries.

**POLICY**

Because environmentally sound and sustainable agriculture requires the proper selection, application, storage, and disposal of agricultural chemicals, A.I.D. policy is to implement IPM tactics wherever appropriate. This policy includes:

oMinimal pesticide use;

oJudicious pesticide selection;

oDiscouraging general requests for pesticides;

oEmphasis on non-chemical pest management tactics;

oInfrastructure development for proper pest and pesticide management, including regulation of pesticide manufacturing, labeling, distribution, worker and public exposure levels, application, storage, and disposal;

oCommunication of U.S. policy and experiences to other nations and international organizations;

oPromotion of supplements or alternatives to vector control that do not involve toxic chemical use; and

oEncouraging host country efforts to research improved pest management methods (A.I.D., 1988).

A.I.D. has discontinued procurement of pesticides on a non-project basis under the commodity import program, except in emergencies and cases of compelling circumstances. Pesticides have been eliminated from the list of commodities automatically eligible for A.I.D. financing. As discussed in Chapter III, requests for the use of pesticides as part of projects are reviewed on a case-by-case basis (A.I.D., 1978).

**Specific IPM Strategies**

Because each IPM system should be specifically designed for particular geographic locations, crops, pest complexes, and resource availabilities, it would be unrealistic for A.I.D. to create policies on which specific IPM tactics must be incorporated into every site-specific IPM strategy. In this context, appropriate research is a fundamental component of IPM and is encouraged, and funded where appropriate, by A.I.D.

**Host Country Legislation**

It is A.I.D. policy to support the creation and implementation of laws and regulations, consistent with U.S. laws and regulations, that will maximize the benefits derived from pesticide use while minimizing potential adverse environmental impacts in developing countries (A.I.D., 1978). Host country legislation should cover all aspects of pesticide involvement, such as control of imports, registration, sale, distribution, use, marketing, training, licensing, certification, storage, transport, disposal, tolerance levels on agricultural commodities, and enforcement. A.I.D. complements pest management programs with appropriate efforts to strengthen institutional capabilities and scientific expertise. According to 22 CFR 216, A.I.D. requires that U.S. technical assistance and donated equipment be used only in conjunction with the application of pesticides approved by A.I.D. For example, in recent locust and grasshopper plagues, A.I.D. prevented the use of pesticides such as dieldrin and benzene hexachloride (BHC) because of their environmental persistence and acute toxicity.

**Training**

It is A.I.D. policy to assist developing countries in the establishment and implementation of regulations, consistent with U.S. regulations, that will reduce pesticide-related risks to the environment and humans (A.I.D., 1978). Attaining the goals of this policy involves training to increase a host country's capabilities in pesticide procurement, formulation, labeling, storage, application, and disposal. This includes training assistance to host country governments to enhance their institutional capacity to maintain control over pesticide availability, production, and use. Training should be aimed at all levels of pest and pesticide management, from government decision makers to pesticide applicators and farmers.

**Pesticide Selection**

A.I.D. pesticide purchases are effectively limited to chemicals registered in the United States by the Environmental Protection Agency. Assistance for the procurement or use of pesticides may be approved by a Bureau Environmental Coordinator only after a thorough examination as stipulated in 22 CFR Part 216 (see Chapter III and Appendix A for further information). In general, it is preferable to select the pesticide least hazardous to humans and the environment that is effective against the target pest and that has U.S. Environmental Protection Agency (USEPA) registration for same or similar use without restrictions. Some pesticides (e.g., those used against tropical pests not found in the United States) are not registered in the United States because there is little or no use for them there; they may or may not be hazardous to the environment and human health (Chapter III). These pesticides would only be considered for use if it can be proven that no USEPA registered pesticides can work, that sufficient toxicological data exists and is comparable to that required by USEPA for registration and, in the case of agricultural production programs, that no alternative crops can be grown, even if they are not as economically profitable. At the same time, although 22 CFR Part 216 does not explicitly forbid the use of USEPA-restricted pesticides, application of such chemicals in the United States can be accomplished only by state certified technicians. Comparable certification programs are generally nonexistent in developing countries, which is a viable reason for discouraging their use in pest control operations, unless the project develops such certification programs and monitors their effectiveness. A.I.D. will not approve any pesticide that has been cancelled or banned by USEPA.

**Local Currency for Pesticide Procurement**

Since the mid-1950's, PL-480 and related food-aid programs have supported natural resources conservation in developing countries. It is A.I.D. policy to use PL-480 resources for inter alia reforestation, agroforestry, watershed management, soil conservation, and habitat protection. A.I.D. is committed to ensuring that projects funded by local currency are environmentally sound. Because IPM strategies are aimed at mitigating environmental injury, IPM would be a viable alternative to sole reliance on chemical control of pests. IPM, however, does not preclude the use of pesticides, which are in many cases an integral component of IPM systems. A.I.D. may approve a country's use of PL-480-generated local currency to finance procurement or use of pesticides applied as part of an IPM program or not, but such use must be reviewed in the same manner as A.I.D. financed pesticides (as discussed in Chapter III).

**Donor Coordination**

It is a critical element of A.I.D.'s pesticide and pest management policy that pest management activities be coordinated with other donors, international organizations, and U.S. agencies (A.I.D., 1978). A.I.D. works with other bilateral donor agencies through the Development Assistance Committee of the Organization for Economic Cooperation and Development (OECD), multilateral development banks, and international organizations such as FAO. Donor coordination is especially important at local levels to avoid shortages of materials as well as to reduce overstocking of pesticides, duplicative efforts, and providing a multiplicity of products.

**Pesticide Storage, Handling, Application, Labeling, Transport, and Disposal and Monitoring Human Health**

It is A.I.D. policy to promote safe and effective pesticide operations to protect human life and the environment (A.I.D., 1988). A.I.D. policy, however, does not specify particular protocols for pesticide storage, handling, application, labeling, transport, and disposal, and monitoring human health (see Chapter V). Although A.I.D. is studying improved methods for application and disposal, specific "best" techniques to accomplish these tasks have not been identified or incorporated into formal policy. At this time, recommendations to refine pesticide storage, handling, application, labeling, transport, disposal, and safety practices (including any recommendations on residue tolerance levels for agricultural commodities) are included in the Environmental Assessments (EAs) conducted by A.I.D. These recommendations, as part of these environmental impact documents, must be approved by the appropriate Bureau Environmental Coordinator.

# CHAPTER II
# STRATEGIES FOR PEST MANAGEMENT

Humans have long competed with a wide variety of organisms over limited food, fiber, and other resources. With the advent of synthetic organic pesticides in the 1940's, many experts thought that a panacea to pest problems had finally been found. In the decades since, it has become increasingly apparent that total reliance on chemical pesticides is at best only a temporary solution and at worst greatly exacerbates pest problems and contributes to increased environmental contamination. Pests, particularly insects and disease, have demonstrated a remarkable ability to rapidly adapt to new environmental pressures, including pesticides. Efforts have now been redirected toward devising and implementing schemes to maintain pest populations at economically acceptable levels while causing minimal negative effects to the environment.

Pest control activities can be divided into three main approaches: exclusion, eradication, and management of established pests. **Exclusion methods** are used to decrease the possibility of pests entering areas where they did not formerly exist. **Eradication** is aimed at completely eliminating pest species from defined geographic areas. **Pest management** seeks to maintain pest damage at levels below economic injury levels; the current paradigm for managing established pests is integrated pest management, which employs all appropriate pest management tactics to reduce damage with minimal chemical inputs. The relative utility of one approach over another depends on the situation and the resources available. A.I.D. encourages integrated pest management and exclusion and quarantine as its methods of choice in pest management.

## EXCLUSION/QUARANTINE

There are many examples of pests entering geographic areas where they did not formerly exist. Two recent cases are the cassava mealybug, which was introduced from South America into sub-Saharan Africa in the early 1970's, and the New World screwworm, which moved from South America to North Africa in 1988. Introduced pests often cause much greater damage in their new habitats than in their places of origin because they are relatively free from regulation by natural enemies. This is certainly the case with the cassava mealybug, an insect so innocuous in South America that it was an undescribed species before being introduced to Africa. On the other hand, there are cases where an introduced species cannot survive the new environment. A recent example is the desert locust that was carried by an unusual weather front to the Caribbean. Within a matter of weeks, the panic of a potential disaster was dispelled by a combination of the insects' inability to breed in the Caribbean environment and natural predators that consumed them.

The goal of exclusion is to keep pest species from entering new geographic areas by restricting the human-assisted movement of plants and animals. For example, soybean rust, a fungal disease, has to date been excluded from entry into the United States from South America. Successful exclusion depends on a well-organized system for detection and quarantine so that pests can be eliminated before becoming established over a wide geographic area. The Plant Protection and Quarantine division of the U.S. Department of Agriculture's Animal and Plant Health Inspection Service--USDA/APHIS/PPQ--has the mandate for regulating the movement of plants and animals both into and within the United States. The interception of more than 15,000 infested items annually at U.S. ports of entry is testimony to the success of the APHIS detection and quarantine system. Many developing countries lack well-developed systems for detecting and eliminating introduced pests and should be encouraged to institute systematic quarantine procedures.

## ERADICATION

The aim of eradication is to completely eliminate pest species from defined geographic areas. If successful, eradication eliminates any future need for control of the target pest. Sometimes referred to as "total pest management", eradication is most often initiated against introduced pest species before they become established over large geographic areas and when the economic consequences are potentially great. A high-quality detection and survey network is needed to geographically focus the eradication effort. Eradication is only appropriate in limited situations and has been successfully employed in only a few cases, most notably with the New World screwworm in North America.

Eradication of the screwworm relies primarily on three types of control strategies: release of sterile insects (autocidal control), chemical control, and the destruction of hosts. These are briefly discussed below.

**Sterile Insect Releases**

A control strategy developed by the USDA, sterile insect release refers to the mass rearing and release of sexually sterile insects of the target pest species. The sterilization is most commonly achieved through radiation. Once released, sterile males mix with the wild population and mate with fertile females. These matings produce non-viable eggs. If sufficient numbers of sterile males are released, the target pest population will gradually decline and become extinct. The sterile insect approach has been used with variable success against the New World screwworm in North America, the tsetse fly in Africa, and fruit flies in several locations. The likelihood of success for this approach is higher for pest species in which the female mates only once in its lifetime. The likelihood of success is also increased if the released sterile males are competitive with the wild males in the natural population. If the released insects do not compete well with wild insects, much higher numbers of sterile males must be released.

**Chemical Control**

Pesticides, either alone or in combination with the sterile insect technique, are often used in eradication and control programs. In some cases pesticides in bait formulations are used to attract and kill the pest species. This "bait and kill" strategy has been used in the United States in eradication programs against the Mediterranean fruit fly.

**Host Destruction**

In cases where pests have limited host preferences, it may be possible to eradicate a newly introduced pest by temporarily destroying all of the hosts in the infested area. This technique was effectively used in 1915 to eradicate citrus canker disease from Florida by destroying more than three million citrus trees. Host destruction is an extreme approach that is not generally encouraged by A.I.D.

**MANAGEMENT OF ESTABLISHED PESTS (IPM)**

Pests that are indigenous to an area (or introduced pests that have become widely established) can be managed by a variety of methods, including biological control, host resistance, cultural control, and the use of pesticides. The current practice is to use combinations of these techniques to manage pest populations so that their numbers remain below economically damaging levels with minimal disruption to the ecosystem. This approach is called integrated pest management (IPM)--sometimes referred to as integrated pest control (IPC) in European countries.

The concept of IPM has frequently been misunderstood by politicians, administrators, and the general public. IPM is an approach rather than a specific solution. Yet IPM is sometimes considered to be a specific solution that can be easily adapted and applied to any pest problem in any geographic area. This misconception has, in some IPM programs, led to confusion, overly great expectations, and disappointment.

One of the earliest and most widely quoted definitions of IPM (IPC) was developed by FAO (1967):

> [IPM is a] pest management system that in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods, in as compatible a manner as possible and maintains pest populations at levels below those causing economic injury.

Successful IPM programs depend on a thorough understanding of pest populations, the associated ecosystem, and the available management tactics. Only with this understanding can strategies be developed that maintain the pest density below economically important levels with minimal perturbation to the ecosystem. To a large extent, IPM is area specific. Therefore IPM strategies must be tailor-made for specific crop/pest complexes in particular locations. This demands a long-term commitment to applied research.

Bottrell (1979) has proposed four guidelines for the development of IPM strategies:

1. **Analyze the "pest status" of each of the reputedly injurious organisms and establish economic thresholds for the "real" pests.** The organisms we perceive to be pests do not always merit this status. Likewise, pests that are economically important are not always obvious. Research is needed to determine which organisms, at what densities, and at what crop growth stages cause economic damage. Only then can we begin to develop strategies to manage the "real" pests.

2. **Devise schemes for lowering the equilibrium positions of key pests.** Population densities of organisms tend to fluctuate around a general equilibrium position. This equilibrium level is determined by the resources available (food, water, shelter), the weather, and the impact of natural enemies attacking the population. Often, the equilibrium level is influenced by human activities. When a pest is accidentally introduced to a new area, it often encounters an environment free from natural enemies. If the environment is favorable, the pest can reach higher levels than were possible in its native home. This new level could theoretically be reduced by introducing natural enemies, modifying cultural practices, use of resistant host varieties, the judicious use of pesticides, or combinations of these methods.

3. **During emergency situations, seek remedial measures that cause minimum ecological disruption.** When pest populations fluctuate above the levels determined to be economically important, interventions, often in the form of pesticides, are needed to avoid unacceptable losses. Care must be taken to ensure that these interventions have the least possible negative environmental impact. This can be accomplished through the choice of pesticide (see Chapter III), method of application, timing of treatment, and use of alternative non-chemical practices.

4. **Devise monitoring techniques.** Pests, especially insects and diseases, often have enormous reproductive capacity and can rapidly increase to damaging levels. Monitoring pest populations is essential in order to intervene before damage becomes economically unacceptable. Survey programs must be standardized and systematic to ensure accuracy.

## TACTICS OF PEST MANAGEMENT

Following is a brief summary of the major tactics currently available for IPM strategies. Genetic engineering, which is certain to play a role in future pest management programs, is also briefly discussed.

**Biological Control**

All living organisms have natural enemies that attack and feed on them. The deliberate use of natural enemies (parasites, predators, and pathogens) to control pest species is termed biological control, also known as biocontrol. Biocontrol can be a component of IPM but has frequently been used as the sole control tactic. There are three main approaches to biocontrol; classical, augmentation, and conservation. These are briefly discussed below.

Classical Biocontrol

The classical approach to biocontrol refers to the introduction and establishment of natural enemies in areas where they did not previously exist. Classical biocontrol is often the tactic of choice against introduced pest species, particularly when the pest is not considered to be damaging in its native home.

Classical biocontrol attempts to reestablish the natural regulation that occurs in the pest's area of origin. To do this requires an extensive study of the proposed biocontrol agent in its native environment, including information on host range and other factors. Even then it is important to proceed with caution; otherwise, the biocontrol agent could itself become a pest in the new environment.

If it is successful, biocontrol is a highly sustainable pest management tactic and should be used whenever possible. It has not always been successful, however, particularly against indigenous pest species or against pests in row crop ecosystems.

Augmentation Biocontrol

Augmentation biocontrol refers to the mass production and release of natural enemies of pest species. Releases are either inundative or inoculative. Inundative releases are mass releases of natural enemies to control pests that are about to surpass economic injury levels. Inoculative releases are usually made early in the season to allow natural enemies to increase and control pests in the future. Much of the work in augmentative approaches has focused on the use of insect pathogens such as Bacillus popilliae, a milky spore disease of the Japanese beetle. Bacillus thuringiensis, on the other hand, is used more like a pesticide because the bacteria are killed within days by direct sunlight.

Conservation Biocontrol

The conservation approach to biocontrol refers to enhancing the environment so that it is more favorable for natural enemies. Timing a pesticide application so that it has the least effect on natural enemies is one example of conservation biological control. Other examples include strip harvesting to conserve hosts and natural enemies, planting alternative hosts for pests so that natural enemy populations can be maintained, and leaving crop stubble in selected areas so that hosts are available throughout the year. Mixed-cropping [MIXED-CROP?] systems have also been shown in many cases to maintain higher populations of natural enemies than monocultures. Many "traditional" farmer practices inherently support conservation tactics.

**Host Resistance**

Host resistance refers to the selection of plants or animals that express some degree of resistance or tolerance toward particular pests. Host resistance has been effectively used against numerous pests in many crops. Its application against parasites of animals has been more limited.

The advantages of host resistance are obvious. Once a resistant plant is selected, it can be readily multiplied, disseminated to farmers, and incorporated into the farming system, often with little change to the farmer's cultural practices. This control tactic has not always proved durable over time, however. The wide-scale planting of resistant varieties places tremendous selection pressure on the pest population, which has often resulted in the selection of pest strains that are able to attack the crop (breakdown of resistance). Biotechnology is likely to have a major impact in the future development of pest-resistant crops.

**Cultural Control**

Cultural control refers to a wide variety of tactics that are used to make the environment less favorable for the pest species. Examples of cultural controls include the timing of planting or harvest to escape pest damage, flooding of fields, plowing to disrupt the life cycle of insects in the soil, intercropping, and fallowing periods. Cultural controls are often an integral part of the farmer's normal practices and can be disrupted when modern agricultural techniques are adopted. For example, a change from a rotation system to continuous cultivation of peanuts can result in a buildup of root-attacking nematodes. Many "traditional" farmer pest control methods already involve cultural control tactics. Such "traditional" methods should be explored and incorporated appropriately into IPM strategies.

**Physical/Mechanical Control**

Physical/mechanical control is most widely used for the control of weeds (hand or mechanical cultivation) but is sometimes used against insects, diseases, and other pests. Common examples of mechanical control include fly swatters, window screens, and sticky traps. An agricultural example is the culling of diseased plants from a field to prevent disease transmission to healthy plants. The use of physical or mechanical control tactics in agriculture is often limited because of the high labor requirements. Yet "traditional" pest control practices by farmers often use physical/mechanical control techniques and should be incorporated into IPM strategies where appropriate.

**Chemical Control**

Chemical control, although under increasing scrutiny because of its inherent disadvantages, is the only method currently available for controlling certain pests. The use of pesticides will undoubtedly continue, and probably increase, in the coming decade. Nevertheless, pesticides should be used only in cases where less ecologically disruptive methods are unavailable. When pesticides are used, it should be with minimal perturbation to the ecosystem. That can be accomplished through the development and use of economic thresholds, careful choice of pesticide (see Chapter III), and the manner and timing of application.

The disadvantages associated with sole reliance on synthetic organic pesticides have been well documented. These include direct hazards to the user, pesticide residues in food, environmental pollution, pest resistance, resurgence of pests after pesticide use, and the change in status of pests from secondary to primary after pesticide use (i.e., insecticides used against key pests decrease the abundance of natural enemies of other pests, which then increase in importance).

The problem of direct hazards to users is particularly critical in developing countries. It is estimated that developing countries account for only 20% of all pesticide use but for 50% of all pesticide poisonings and 73% to 90% of all pesticide-related deaths. This indicates that the risks associated with pesticide use are much higher in developing countries and that any proposed pesticide use should be accompanied by an intensive training effort to mitigate these risks .

Another problem of chemical control, pest resistance to pesticides, is becoming increasingly common as pesticide usage increases. In 1984, it was estimated that 638 pest species worldwide had resistance to certain pesticides. These include some 428 arthropods, 50 weeds, 150 plant pathogens, and 10 small mammals and plant parasitic nematodes. Strategies to manage resistance are being developed and include rotation of pesticides and pesticide mixtures as well as the extensive use of non-chemical alternatives.

Pesticide residue tolerance levels on agricultural commodities in developing countries generally have not been delineated or else are not systematically monitored or enforced. Because human safety is a primary goal of IPM, the observance of pesticide residue tolerance levels should be encouraged and, if possible, facilitated.

**Insect Behavior Modification**

Semiochemicals are used on occasion, where and when available, to modify insect behavior. Generally, these chemicals consist of pheromones (hormones produced by insects and released into the environment as behavioral cues to other insects) and kairomones (chemicals not produced by insects but having an effect on their behavior--for example, molasses as a feeding attractant or neem extract as a feeding deterrent). Such chemicals may be useful in disrupting insect mating and development, attracting pests to traps, or repelling pests away from crops, among other responses. Because these compounds are generally quite selective regarding the target organism and are usually used in small amounts, semiochemicals are an innovative and effective tactic for incorporation into IPM strategies.

**Genetic Engineering**

Although not yet widely applied in developing countries, biotechnology will provide many new pest management options in the future. For example, plants can now be genetically engineered to produce insecticides that normally are produced only by bacteria. Conversely, bacteria can be engineered to mass-produce insecticides that normally are produced only in plants. Regulations governing the testing, release, and general use of engineered biopesticides are being developed in many countries. Guidance on proposed uses of such pesticides should be sought from AID/W.

# CHAPTER III REGULATIONS FOR ENVIRONMENTAL REVIEW FOR A.I.D.-FINANCED PROCUREMENT OR USE OF PESTICIDES

## INTRODUCTION

A.I.D.'s regulations require that the potential environmental consequences of A.I.D.-financed activities are identified and considered by A.I.D. and the host country prior to the final decision to proceed with an activity. The procedures that guide this regulation are set forth in 22 CFR Part 216. Section 117(c) of the Foreign Assistance Act and Section 533(g) of the 1991 Appropriation Act require that A.I.D. review its projects, programs, and activities in accordance with the requirements of 22 CFR Part 216. A.I.D.'s policy is to approve for procurement or use only those pesticides that are critically needed and proven safe.

22 CFR Part 216 includes specific instructions for examining A.I.D. projects that include funding for the use or procurement of pesticides. ("Use" includes the procurement or use of equipment and technical assistance in connection with pesticide use, storage, transport, and disposal even if the host country or another donor is funding the actual procurement.) For such projects, Project Identification Documents (PIDs) and Project Papers (PPs) include a review of the proposed action for pest control as it relates to the environment. The first step in this review is called the Initial Environmental Examination (IEE). The IEE provides the basis for a "threshold decision" as to whether an Environmental Assessment (EA) is required prior to project implementation or whether no further environmental review is necessary. (For certain actions that affect the environment of the United States, the global commons, or areas outside the jurisdiction of any nation, an Environmental Impact Statement (EIS) may be required in accordance with the National Environmental Policy Referendum; virtually no A.I.D. actions are in this category, however, and it will not be discussed further.) Depending on the USEPA registration status of the proposed pesticide(s), an EA or EIS may be mandatory. In cases where an EA or EIS is mandatory, the IEE may be omitted from the review process. Precise definitions for the IEE, the EA, and the EIS are provided in 22 CFR Part 216.

**Project Officers are held responsible for complying with the requirements of 22 CFR Part 216 during the design and implementation of activities involving the use or procurement of pesticides.** The information in this chapter should be viewed as a brief introduction to A.I.D.'s pesticide regulations but not in any way as interpretation of, or a replacement for, 22 CFR Part 216. The complete text of 22 CFR Part 216 is included in Appendix A.

## RELATION OF USEPA REGISTRATION STATUS TO ENVIRONMENTAL PROCEDURES

The procedures for evaluating the environmental consequences of an action in which A.I.D. finances procurement or use of pesticides depend on the USEPA status of the proposed pesticide (see Figure 1). USEPA-registered pesticides are treated differently from those that do not have USEPA registration because the registered chemicals have undergone a thorough multi-million dollar, multi-year, risk evaluation and have been found to be acceptable in the United States.

USEPA-registered pesticides are evaluated first in an IEE to determine whether they will cause significant harm to the environment where they will be used. If not, no further review is required. If the proposed use of USEPA-registered pesticides will have a significant adverse effect on the environment, an EA must be completed. The only exception to this rule is for pesticides that are registered for same or similar use, but are restricted for environmental reasons by the USEPA. Pesticides in this category must automatically be examined in an EA. Pesticides that are not registered for same or similar use by the USEPA also must automatically be examined in an EA.

FIGURE 1.

**ISSUES TO BE ADDRESSED IN AN IEE**

Several specific factors that must be considered in preparing an IEE for the review of USEPA-registered pesticides. Other factors may also be examined in the IEE as appropriate.

Factors that must be considered in preparing an IEE include the following:

1. **USEPA registration status of the proposed pesticide:** As mentioned earlier, the USEPA status of the proposed pesticide dictates the procedures to be followed in the environmental review process. The USEPA document "Suspended, Cancelled, and Restricted Pesticides" is useful for identifying pesticides against which the USEPA has taken specific regulatory action. This document is published periodically, but may not include very recent USEPA regulatory actions. (See Appendix B for information about this and other sources of assistance on the USEPA status of pesticides.)

2. **Basis for selection of the pesticide:** This section of the IEE includes the economic and the environmental rationale for choosing a particular pesticide. In general, the least toxic pesticide that is effective (and that has USEPA registration for same or similar use) is selected.

3. **Extent to which the proposed pesticide use is, or could be, part of an IPM program:** A.I.D. policy promotes the development and use of integrated approaches to pest management whenever possible. This section of the IEE discusses the extent to which the proposed pesticide use is incorporated into an overall IPM strategy.

4. **Proposed method or methods of application, including the availability of application and safety equipment:** This section examines in detail how the pesticide is to be applied and the measures to be taken to ensure its safe use. Some situations, for example, may favor ground application over aerial application because of the problems of spray drift beyond the target area.

5. **Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards:** This section of the IEE examines the acute and chronic toxicological data associated with the proposed pesticide. The proposed use of acutely and highly toxic pesticides (e.g., parathion) must be thoroughly justified, as must the use of any pesticide known or suspected to have chronic affects on humans or other non-target organisms.

In general, A.I.D. discourages the use of pesticides classified by USEPA as "restricted use pesticides." Such pesticides can be used in the United States only by or under the direct supervision of certified applicators; this is because USEPA has determined that these pesticides may cause unreasonable adverse effects on the environment and the applicator when they are used in accordance with widespread and commonly recognized practices in the United States.

Developing countries generally do not have comparable certification programs for pesticide applicators. Assistance components to develop some form of training and/or certification should be considered if restricted-use pesticides are needed. In addition to hazards, this section of the IEE also discusses measures designed to mitigate any identified toxicological hazards, such as training of applicators, use of protective clothing, and proper storage.

6. **Effectiveness of the requested pesticide for the proposed use:** This section of the IEE requires information similar to that provided in item 2, but more specific to the actual conditions of application. This section also considers the potential for the development of pest resistance to the proposed insecticide.

**7. Compatibility of the proposed pesticide use with target and non-target ecosystems:** This section examines the potential effect of the pesticide on organisms other than the target pest (for example, the effect on bee colonies kept in the area). Non-target species of concern also include birds and fish. The potential for negative impact on non-target species should be assessed and appropriate steps should be identified to mitigate adverse impacts. Note: The IEE examines facts that indicate whether there will be harm. The EA considers mitigating measures.

**8. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils:** This section examines issues such as the potential for contamination of surface and groundwater sources.

**9. Availability of other pesticides or non-chemical control methods:** This section identifies other options for control of pests and their relative advantages and disadvantages.

**10. Host country's ability to regulate or control the distribution, storage, use, and disposal of the requested pesticide:** This section examines the host country's existing infrastructure and human resources for managing the use of the proposed pesticide. If the host country's ability to regulate pesticides is deemed inadequate, the proposed action might result in significant harm to the environment, which must be considered in the EA.

**11. Provision for training of users and applicators:** A.I.D. recognizes that safety training is an essential component in programs involving the use of pesticides. The need for thorough training is particularly acute in developing countries, where the level of sophistication of applicators may typically be lower than in developed countries.

**12. Provision made for monitoring the use and effectiveness of the pesticide:** Evaluating the risks and benefits of pesticide use should be an ongoing dynamic process.

Depending on the responses provided in the IEE to the above issues, the originator of the project (generally a Mission) will recommend a positive or negative determination of whether further assessment of the potential environmental consequences is necessary. The appropriate Bureau Environmental Coordinator (BEC) will either concur with the determination, or request that the originator reconsider the Decision. A negative determination indicates that the Agency is satisfied that the proposed action will not cause significant harm to the environment. A positive determination indicates that significant harm is foreseeable and the environmental consequences of the program need to be examined in greater detail in an EA.

**THE SCOPING EXERCISE**

The issues to be addressed in an EA are outlined during a scoping process, described in 22 CFR 216.3(a)(4). Scoping is initiated by the Mission proposing the activity. Scoping attempts to identify issues of significant environmental importance and to eliminate issues that are unlikely to have a significant environmental impact. The scoping exercise also addresses programmatic considerations such as the time frame and resources necessary for conducting the EA. A scoping team typically includes the project officer, an environmental expert, a host country government representative, and representatives of relevant host country non-governmental organizations. A typical scoping exercise takes one to five days and results in a specific statement of work for the EA.

Once it is completed, the scoping exercise can be circulated to other federal agencies for comments if the Bureau Environmental Coordinator believes such comments would be useful. One possible, albeit rare, outcome of the scoping exercise is a change in the Threshold Decision from positive to negative; this could occur if it becomes evident during the scoping process that the proposed actions will have no significant impact on the environment.

**ISSUES TO BE ADDRESSED IN AN ENVIRONMENTAL ASSESSMENT (EA)**

The EA is an in-depth examination of the environmental issues associated with a proposed A.I.D.-funded activity. In general, the EA examines in detail the issues to be discussed in IEEs (216.3(b)1(1)(i)), but it also addresses other significant issues identified during the scoping process, such as the impact of the proposed action on endangered or threatened species. An important component of the EA is an examination of the potential environmental consequences of alternatives to the proposed action, including any non-chemical possibilities; one of the alternatives considered should be the "no-action" approach. The EA must also include specific recommendations on how project implementation can be improved to mitigate adverse impact on the environment or human health and how the project evaluations will formally include compliance with the EA. The EA follows a prescribed format, which is described in 216.6(c)(1-7). Summarized examples of EAs conducted by A.I.D. are provided in Appendix C.

**EAs AND PROJECT AMENDMENTS**

In the event of amendments to projects, EA assumptions and recommendations may be rendered obsolete depending upon the substantive nature of the amendment(s). If the amendment is substantive (e.g., use of an additional pesticide, expansion of pest management activities into a new area or crop, use of a different pesticide application method),there may be a need to revise or amend the EA to appropriately address changes in the project. Similarly, if new information is discovered which affects the pest management aspects of the project (e.g., the pesticide(s) used in the project are banned or placed in the restricted use category by EPA, or susceptible non-target organisms are identified in or near the site of operations), the EA must be revised or amended accordingly. Also, if an EA has not been conducted prior to project authorization (or if the pesticides to be used in the project are not identified until the project implementation phase), an EA is still required and must be completed retroactively. In each of these cases, the project officer must consult with the appropriate Bureau Environmental Coordinator to determine the best course of action.

**EXEMPTIONS FROM 22 CFR PART 216**

A.I.D. is exempted from fulfilling the requirements of 22 CFR Part 216 in certain limited situations. These include emergencies, as determined in writing by the A.I.D. Administrator, multi-donor projects where A.I.D. is a minor donor and where the Agency Environmental Coordinator had determined that the controlling donors' pesticide procedures are adequate, projects using small quantities of pesticides for research purposes, and, under very restricted conditions, non-project assistance. Exemptions are rarely granted, however, and efforts to fulfill the spirit of 22 CFR Part 216 should be undertaken even under emergency conditions. Consult 216.3(b)(2-3) and with the relevant Bureau Environmental Coordinator for specific information on the conditions that must be met before exemptions to 22 CFR Part 216 can be considered.

**ROLE OF AGENCY ENVIRONMENTAL STAFF**

**Mission and Regional Office Environmental Officers**

Many Missions and Regional A.I.D. Offices (REDSO/EA, REDSO/WCA, ROCAP) have designated Environmental Officers and/or contract environmental advisors. These people are the first source of information in the Mission or sub-region on A.I.D. Environmental Procedures. The Mission Environmental

Officer or Advisor (MEO or REA) and/or Regional Environmental Officer (REO) review proposed project activities for their potential environmental impact and provide advice on the application of 22 CFR Part 216 regulations. MEOs/REOs play an important role in recommending when categorical exclusions to 22 CFR Part 216 are applicable, when exceptions to pesticide procedures apply, and, when IEEs are prepared, whether Threshold Decisions are positive or negative. (See 216.2(c)(2)(i-xv) for a list of activities that may be excluded from environmental examination.) MEOs/REOs also coordinate and provide guidance on the scoping exercise and the preparation of EAs. MEOs/REOs are not authorized to approve IEEs or EAs. This function is reserved for the Bureau Environmental Coordinators.

**Bureau Environmental Coordinator**

Bureau Environmental Coordinators (BECs) have an extremely important role in assuring that A.I.D. activities are implemented and conducted in an environmentally sound manner. Specifically, the BECs must review the appropriateness of all categorical exclusions to 22 CFR Part 216, review and approve IEE Threshold Decisions originating from Missions in their respective Regions, review the written description of the scoping process, and approve all Environmental Assessments. If a BEC does not approve a specific Mission Threshold Decision, he or she can request that the originating Mission reconsider the Decision. When differences of opinion cannot be resolved at this level, the Assistant Administrator for the concerned Regional Bureau reviews the Threshold Decision and makes the final determination.

**Agency Environmental Coordinator**

The Agency Environmental Coordinator is responsible for monitoring overall Agency compliance with 22 CFR Part 216 regulations and for developing Agency strategies and policies that will ensure that all A.I.D.-funded activities are conducted in an environmentally sound manner. 22 CFR Part 216 specifies a few situations in which the Agency Environmental Coordinator must be involved: determining whether the requirements for a "minor donor" exception to 22 CFR Part 216 are met (216.1(12)(ii); circulating EAs that are not country-specific to concerned Missions and host countries for comments (216.6(e)(2); coordinating external communications required for the review of EISs (216.7-8); and serving as a conduit for responding to requests for information on EAs and EISs under the Freedom of Information Act (216.10).

# CHAPTER IV
# PEST MANAGEMENT IN PROJECT DESIGN

Both in goal and by mandate, Agency programs are designed to consistently promote sustainable productivity and to maintain or enhance the natural resource base in recipient countries. Actions that address these issues are to be built into all A.I.D. projects.

Most experts and A.I.D. view the pesticides-only approach to pest management as an unsustainable, counterproductive and environmentally detrimental practice. A multifaceted approach brings several non-pesticidal, sometimes traditional, methods to bear either in place of or in addition to pesticides. A.I.D. is examining new projects for ways of adopting this integrated approach.

An integrated approach to pest management often involves research, training, and evaluation--activities that happen only when planned and budgeted. The purpose of this chapter is to provide guidance on how pest management awareness and activities can be incorporated into projects during the design process and, more specifically, how pest management issues can be integrated into various stages of project documentation (see Figure 2). Documents submitted outside of the design process, umbrella projects, and non-project assistance efforts are briefly discussed at the end of this chapter.

## KEY CONSIDERATIONS

For background, several general points should be made:

1. All A.I.D. officers who design, implement, evaluate and approve projects must be aware of the requirements in A.I.D.'s Environmental Procedures (Chapter III) so that they are included as part of project design in project documents and acted on during the project.

2. As with all other aspects of the project, the recipient country should be actively involved in planning, implementing and evaluating the pest management component of the project.

3. Will the project involve the sale, brokerage, trade, packaging, bottling, storage, use, transport, or disposal of pesticides? The earlier in project design this question is addressed, the easier it will be to plan acceptable mitigative measures. It may not be clear that pest management is a part of the project. For example, projects that support intermediate credit institutions provide funds to farmers who may or may not use those funds to purchase pesticides. In such cases, the nature of follow-on project activities should be identified and, to the extent possible, A.I.D.'s Environmental Procedures should be observed or the intermediate credit institutions should be strengthened to be able to apply their own environmental assessment procedures.

4. Project budgets should include line items for pest management assessments, training or research.

5. Outside advice on technical aspects of project pest management strategies can be accessed if needed at any stage in project design. See Appendix B for a list of resources.

6. Different offices have different names for project planning documents. The need for pest management in the project should be considered and discussed at all stages and in all pertinent documents, regardless of what the documents are called.

Figure 2.

## DOCUMENTS

### Country Development Strategy Statement (CDSS)

Country Development Strategy Statements are multi-year strategy documents that summarize a country's social and economic development status, its development plans and resources, and A.I.D.'s assistance strategy within the country. The CDSS provides the rationale and setting for current projects and often prompts ideas for new projects.

Central Bureaus in Washington develop a somewhat comparable document, the Central Program Strategy Statement (CPSS). This document outlines long-term Bureau goals in the context of A.I.D.'s policy.

These documents usually do not describe specific actions but instead discuss in broad terms the strategies used in A.I.D.'s health, agriculture, environment, and other development programs in countries or Bureaus. Pest management, although not usually discussed in detail, is often mentioned. For example, many CDSSs discuss A.I.D.'s role in efforts to enhance agricultural productivity, which often means that the Agency supplies inputs such as fertilizers and pesticides to the project. Sections of the CDSS devoted to description of health programs often mention vector-borne disease control efforts--efforts that involve pest management.

The CDSS should include, either in the sectoral sections of the document or in a separate "Pest Management" section, the Agency's and Mission's commitment to safe and sustainable pest management through an integrated approach. For instance, efforts to bolster the agricultural capabilities of the country should include training and research in the safe use of pesticides and in the development and use of alternatives, such as resistant plants or biological control. These points can be made briefly, but strategically, in the CDSS or CPSS. Any reference to pest management in these documents will set the stage for all projects that follow.

### Action Plan (AP)

With a CDSS in place, Missions prepare Action Plans every year to focus specifically on how current programs and projects contribute to objectives outlined in the CDSS and on how new initiatives will help address issues raised in the CDSS. The AP links the long-range objectives in the CDSS to more detailed plans for activities. Central Bureaus may also develop an AP (usually every 3-5 years) as a means to assess progress on current projects and to identify new projects. APs often include a section titled Forward Plans, which discusses short-range objectives and benchmarks for current projects. Plans for research, training, and evaluation may appear in the body or annexes of the AP.

Project officers involved in overseeing pest management activities should contribute brief descriptions of activities and objectives to the AP. If pesticide procurement, use, storage, transport, and/or disposal is contemplated, then accompanying safety training should be briefly described. Descriptions of pesticide monitoring efforts are appropriate in discussions of evaluation or research plans. Likewise, efforts to identify, develop, or use alternative management strategies should be discussed in sections on research and/or environmental efforts.

Useful alternatives to pesticides often exist, and it is incumbent on the project officer to try to bring them to bear on the project. By considering pest management at this stage in project design, designers will have the luxury of time needed to incorporate alternatives into projects.

### New Project Document

This document is called a New Project Description (ANE and LAC) or a New Project Narrative (AFR) or a Concept Paper (RD). A New Project document briefly describes the problem that the new project will address

and the proposed solution offered by the project. Requirements for temporary duties (TDYs), consultants, baseline data, and monitoring and evaluation are provided.

As project officers foresee the need, specific pest management components in the project should be described. More than providing the details of what will be done, it is important to discuss the strategy that will be followed on the project. If only pesticides are used for control, then some justification should be provided. If alternatives will be used, then their availability and integration into the project should be described.

Budget line items for design specialists in pest management training and for pesticide monitoring should be included. If alternative pest management methods are to be used, then the political/social acceptability of those methods may need to be evaluated. If so, plans for this (or other assessments) should be mentioned and figured into the budget.

**Project Identification Document (PID) And Initial Environmental Examination (IEE)**

By this stage in project design, the responsible staff officer in most cases should have a clear idea about the pest management strategies that will be used as well as how those strategies will be implemented.

At the PID stage in project design, all budget line item requirements for pest management in the project should be described. These include, for example, the costs of conducting an EA, other assessments, training, research, or social studies, the costs of equipment, and the costs of contractors. An abbreviated Logical Framework is sometimes included in the PID.

The PID includes the IEE, which is the first formal review of the project's pest management implementation plans. As a matter of simplification, all projects involving pesticides require a brief IEE with a positive determination.

**Project Paper (PP) And Environmental Assessment (EA)**

The Project Paper includes all the information needed to justify, explain, and implement the project. The Logical Framework, which is included in the PP, provides the goals and objectives against which project progress will be measured.

If pest management is to be a part of the project, then all related plans should be described in the PP. Pest management objectives (e.g., sustainable control of pests, training of pest managers, or start-up of pest management research programs) should be included in the Logical Framework, with objectively verifiable indicators (e.g., crop damage level assessments, numbers trained) clearly indicated so that progress can be measured. The budget should identify by line items those funds that are earmarked for pest management.

The PP also includes the EA which is done simultaneously with and as part of PP design (see Chapter III). As part of project design, specific pest management recommendations from the EA must be incorporated in the PP. Ideally, if pest management has been considered throughout project design, recommendations will be few and will be easily incorporated into the project.

All projects involving pesticides will formally assess compliance with the EA in all project evaluations.

**Project Agreement (PROAG)**

Based upon the approved PP, the Project Agreement (PROAG) describes how A.I.D. and the host country government will collaborate on the project. Generally a brief description of the project is followed by discussion of financial arrangements.

A.I.D. makes every effort to ensure that the recipient country's government is made aware of and consents to the proposed pesticides and their use. The PROAG is the appropriate document for describing any proposed use and describing how, based upon the EA, mitigations and alternatives will be used. Involving recipient country representatives on pest management issues early in the project will minimize difficulties at this late stage. Once the PROAG is signed by all parties, the project is ready for implementation.

**Annual Budget Submissions (ABS)**

The Annual Budget Submission is prepared by Missions and by Bureaus or Offices in Washington. The bulk of the ABS is made up of tables that summarize the status of accounts and list funding projections. Trends are reflected in the tables, and usually are briefly summarized in comments at the front of the ABS. Depending on the importance of pest management projects in the management unit, it may be appropriate to comment on the level of effort being devoted to such projects--either by identifying funds by line items (e.g., "Pest Management Research," "Safe Use of Pesticides Research") and/or by briefly describing pest management allocations in the preface. The ABS generally provides much of the information that goes into the Congressional Presentation.

**Congressional Presentations (CP)**

The Congressional Presentation (CP) is the Agency's annual submission to the Congress that describes funding requirements for the upcoming budget year. The CP contains new project descriptions and is in large part made up of tables. Also, the CP describes directions and priorities in the Agency. Congress is interested in pest management policy in A.I.D.-funded programs. The CP is the crucial document that describes and justifies Agency plans to the Hill. Along with descriptions of sectoral efforts, Missions, Bureaus, and Offices should comment on pest management strategies in Agency programs. For example, discussions of agricultural productivity should clearly describe the approaches to pest management that will be used. Similarly, levels of effort for pest management programs should be easily identified in budget tables.

**UMBRELLA PROJECTS**

Many A.I.D. projects are structured so that subprojects such as grants or cooperative agreements will be supported under the project. Frequently the nature of the subprojects is not completely clear when the large umbrella project is being designed. As each subproject is proposed it should be reviewed per Regulation 216 for pest management components, and plans for such a review should be described in the umbrella project's EA. The previous discussion also relates to project amendments and extensions.

**NON-PROJECT ASSISTANCE**

When A.I.D. provides funds, credit, or commodities outside of the context of projects, the responsible A.I.D. staff officer should assure that, to the extent possible, assistance for pest management activities is used responsibly and in keeping with A.I.D.'s Environmental Regulations.

A.I.D. has discontinued procurement of pesticides on a non-project basis under the commodity import program, except when the approval of the Administrator is obtained in the cases of emergencies and other extraordinary and compelling circumstances. Pesticides have been eliminated from the list of commodities automatically eligible for A.I.D. financing. Requests for the use of pesticides as part of projects are reviewed on a case-by-case basis (Chapter III) (A.I.D., 1978). Exceptions to this requirement may be granted for research projects, emergencies, and projects in which A.I.D. is considered to be a minor donor (Chapter III).

# CHAPTER V
# PESTICIDE MANAGEMENT

Much has been written about the classification, toxicity, environmental hazards, and safe handling of pesticides. This chapter does not attempt to provide a complete source of information on any of these topics. It does, however, include some general considerations on safe pesticide management as they relate to A.I.D. policy.

## PESTICIDE CLASSIFICATION

Pesticides include a wide variety of compounds designed to destroy a broad range of pest organisms. Pesticides are classified into different groups using various criteria. The most common ways of classifying pesticides are by target organism, chemistry, formulation, and toxicity.

### Target Organism

Pesticides can be classified according to the kinds of organisms that they are designed to kill. Using this scheme, pesticides are separated into insecticides, acaricides, herbicides, fungicides, rodenticides, nematicides, molluscicides, and others. Some pesticides belong to more than one group; for example, carbofuran has both insecticidal and nematicidal properties. Methyl bromide is often characterized as a general biocide because it can be used to kill a wide variety of organisms (plants, insects, and microorganisms). Worldwide estimates indicate that the most commonly used pesticides, in descending order, are herbicides, insecticides, and fungicides. Together these groups account for more than 93% of the pesticide market.

### Chemical Group

Despite the large numbers of products available, most pesticides can be placed in one of a few common chemical groups. For example, the vast majority of insecticides in use today are organophosphates, carbamates, or synthetic pyrethroids. Brief descriptions of the major chemical groups of pesticides, including some of their important characteristics, are presented in Appendix E.

### Formulation

For the end user, classification based on formulation is possibly more important than chemical classification. Formulation refers to the form in which the pesticide is sold to the user. A formulation is a mixture of an active ingredient (i. e., the component that kills the pest) and several other compounds added to facilitate application. These other ingredients include solvents, carriers, emulsifiers, stickers, and others. Some formulations are sold as solids, such as dusts, granules, and wettable powders, others as liquids, such as emulsifiable concentrates, flowables, and ULV (ultra low volume), and some as gases for fumigation. Brief descriptions of common formulations are provided in Appendix E.

### Toxicity

An important and useful way in which pesticides are classified is by toxicity to mammals. Mammalian toxicity provides an indication of the relative danger of different products to humans. Toxicity can refer to a pesticide's short-term effects (acute) or long-term effects (chronic). Acute toxicity is typically measured within 24-48 hours after a single dose, whereas chronic toxicity (e. g., carcinogenicity or mutagenicity) is measured over a much longer period and often after repeated daily dosages.

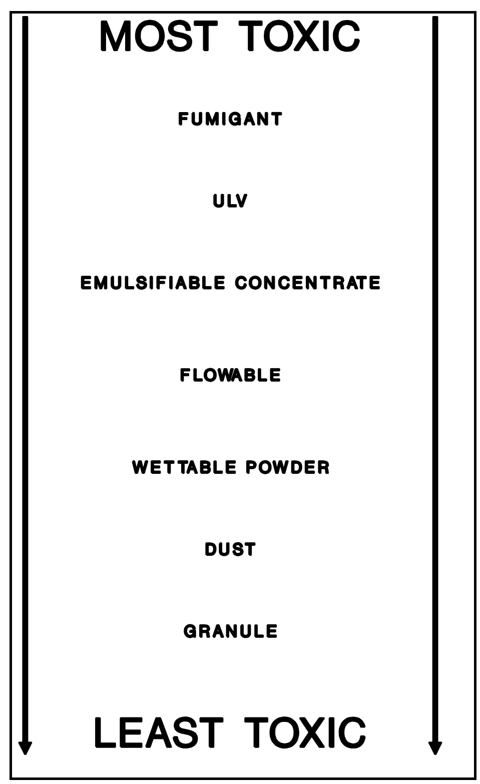
Acute toxicity is further divided into three categories, depending on how the pesticide enters the body: oral, dermal, or inhalation. **The dermal route of entry is the most common way persons are occupationally exposed to pesticides**.

Toxicity is measured in terms of the average dose needed to kill 50% of a test population of animals (usually mice, rats, or rabbits). This is referred to as $LD_{50}$ (lethal dose for 50% of the test population) and is generally expressed in milligrams of pesticide per kilogram of body weight. The lower the $LD_{50}$, the more toxic the pesticide.

The USEPA has divided pesticides into four categories according to their acute oral and dermal toxicities (see Table 1). Category I pesticides are the most toxic and category IV the least toxic. WHO has developed a similar scheme (see Table 2). **Note: The USEPA and WHO toxicity classification systems are different**, e.g., USEPA category III is not the same as WHO category III.

An important concept is that the mammalian toxicity of a pesticide depends to a great extent on how it is formulated. A pesticide formulation that contains a low percentage of a very toxic active ingredient could be less toxic than a formulation that contains a less toxic active ingredient but at a higher percentage. For example, the acute oral $LD_{50}$ for malathion is 1375 mg/kg and for fenitrothion is 800 mg/kg, but a 96% ULV formulation of malathion would be more toxic than a 50% formulation of fenitrothion. The toxicity of a pesticide **formulation** can be calculated using the following:

Since most accidental pesticide exposure is dermal, the hazards to the user also vary with how well the pesticide is absorbed through the skin. Liquid formulations tend to be absorbed much more rapidly than dry formulations. As a general rule, the hazards to the user decrease according to the scheme presented on the right:




**Note:** "Inert" ingredients can be hazards as well; thus, the formula above is only an approximation, as it assumes no toxicity associated with the inert ingredients.

## MONITORING HUMAN EXPOSURE TO PESTICIDES

People who are occupationally exposed to organophosphate pesticides should be tested periodically to determine the extent to which they are being exposed to the pesticide(s). This is done by monitoring the level of an enzyme, acetylcholinesterase (often referred to as cholinesterase), in the blood. Cholinesterase is essential for nerve transmission, which is adversely affected by organophosphate pesticides.

**Table 1. USEPA Labeling Toxicity Categories by Hazard Indicator***

| | Toxicity Categories | | | |
|---|---|---|---|---|
| Hazard Indicators | I | II | III | IV |
| Oral $LD_{50}$ | Up to and including 50 mg/kg | From 50 thru 500 mg/kg | From 500 thru 5000 mg/kg | Greater than 5000 |
| Inhalation $LD_{50}$ | Up to and including 0.2 mg/liter | From 0.2 thru 2 mg/liter | From 2 thru 20 mg/liter | Greater than 20 mg/liter |
| Dermal $LD_{50}$ | Up to and including 200 mg/kg | From 200 thru 2000 | From 2000 thru 20,000 | Greater than 20,000 |
| Eye effects | Corrosive; corneal opacity not reversible within 7 days | Corneal opacity reversible within 7 days; persisting for 7 days | No corneal opacity; irritation reversible within 7 days | No irritation |
| Skin effects | Corrosive | Severe irritation at 72 hours | Moderate irritation at 72 hours | Mild or slight irritation at 72 hours |

* The USEPA has developed additional refinements in its testing requirements and has adjusted these categories in practice to reflect this. For example, the inhalation values in this table are based on a 1-hour exposure, and have been divided by four to reflect 4-hour inhalation exposure (so that category I becomes 0.05 mg/liter for 4- hour exposure, category II becomes from 0.05 to 0.5 mg/liter, etc.). In addition, the duration of the eye observation period now routinely extends to 21 days.

**Table 2. WHO Classification System According to Acute Toxicity**

| Class | Hazard Level | Oral Toxicity* Solids** | Oral Toxicity* Liquids** | Dermal Toxicity* Solids** | Dermal Toxicity* Liquids** |
|---|---|---|---|---|---|
| Ia | Extremely hazardous | 5 or less | 20 or less | 10 or less | 40 or less |
| Ib | Highly hazardous | 5-50 | 20-200 | 10-100 | 40-400 |
| II | Moderately hazardous | 50-500 | 200-2000 | 100-1000 | 400-4000 |
| III | Slightly hazardous | over 500 | over 2000 | over 1000 | over 4000 |

* Based on $LD_{50}$ for the rat (mg/kg body weight)

** The terms "solids" and "liquids" refer to the physical state of the product or formulation being classified.

If properly conducted at periodic intervals, cholinesterase testing can be used to identify persons who are in danger of becoming ill before they show symptoms. Unfortunately, because of differences in the mode of action of various pesticide groups, cholinesterase monitoring is only effective for identifying organophosphate and carbamate poisoning. There are no simple techniques for detecting exposure to other major pesticide groups.

Several methods are available for determining cholinesterase inhibition. A simple pin-prick method, developed for use in the field, provides results within a few minutes. More accurate laboratory testing procedures are also available.

How often to test depends on two factors: 1) the toxicity of the pesticide(s) to which a person is exposed, and 2) the amount of time of exposure. Persons involved in formulation, mixing, and applying pesticides are probably at the highest risk. Truck drivers who transport pesticides but seldom come in direct contact with pesticides are at a somewhat lower risk. The general population is at a very low risk and therefore should not be tested unless an accident occurs that greatly increases their exposure. In general, persons occupationally exposed should be monitored every 1-2 weeks depending on the toxicity of the product they are using. If working with pesticides is seasonal in nature, monitoring should be conducted only during the season of exposure.

Appendix B lists several resource contacts and publications on pesticide intoxification. In particular, it is suggested that Publication No.5, An Agromedical Approach to Pesticide Management: Some Health and Environmental Considerations (available through A.I.D./S&T/AGR) be consulted.

**USEPA LEGAL CLASSIFICATION**

In addition to toxicity categories, the USEPA also separates pesticide formulations into categories based on a risk/benefit analysis. The risks include those to both humans and the environment. The broad categories used by the USEPA are: cancelled, suspended, restricted use, and unclassified.

**Cancelled** formulations (i.e., banned) are those for which the USEPA has determined that the risks outweigh the benefits under conditions of use in the United States. In some cases all uses of an active ingredient have been cancelled (e.g., BHC or benzene hexachloride), while in other cases certain uses are still permitted.

A pesticide formulation or active ingredient is **suspended** if it is determined that it may pose an imminent hazard. Use of the pesticide is halted until the USEPA completes a review to determine whether the pesticide should be cancelled.

**Restricted use** pesticides can be purchased and used only by, or under the supervision of, a state certified pesticide applicator. Certification in the United States is attained by passing a state examination or completing training that complies with minimum federal requirements. The following guidelines have been established to identify pesticides that pose hazards to the user:

**Restricted for residential and institutional uses** if the pesticide:

-as diluted for use, has an acute oral $LD_{50}$ of 1500 mg/kg or less;

-as formulated, has an acute dermal $LD_{50}$ of 2000 mg/kg or less;

-as formulated, has an acute inhalation $LC_{50}$ of 0.5 mg/l or less based on a 4-hour exposure;

-as formulated, is corrosive to the eye or results in corneal involvement or irritation persisting for more than 7 days;

-as formulated, is corrosive to the skin or causes severe irritation at 72 hours;

-when used in accordance with label directions or widespread commonly recognized practices, may cause significant subchronic, chronic, or delayed toxic effects in humans as a result of single or multiple exposures to the product's ingredients or residues.

**Restricted for all other uses (agricultural, vector control, etc.)** if the pesticide

-as formulated, has an acute oral $LD_{50}$ of 50 mg/kg or less;

-as formulated, has an acute dermal $LD_{50}$ of 200 mg/kg or less;

-as diluted for use, has an acute dermal $LD_{50}$ of 16,000 mg/kg or less;

-as formulated, has an acute inhalation $LC_{50}$ of 0.05 mg/l, based on a 4-hour exposure;

-as formulated, is corrosive to the eye or causes corneal involvement or irritation persisting for more than 21 days;

-as formulated, is corrosive to the skin;

-when used in accordance with label direction or widespread commonly recognized practices, may cause significant subchronic toxicity, chronic toxicity, or delayed toxic effects in humans as a result of single or multiple exposures to the product's ingredients or residues.

**Unclassified** pesticides are often referred to as those permitted for "general use." These pesticides are typically less dangerous for the user than restricted use pesticides and can be purchased and used by all segments of society. The use of unclassified pesticides is always "restricted" in a sense, however, by the label instructions; for example, a pesticide may include a statement such as "Do not use this pesticide within 25 feet of any body of water." In the United States, the directions on a pesticide label are considered legally binding, and users who violate them could be subject to civil and/or criminal penalties.

## A.I.D. REGULATIONS

A.I.D.'s policy on pesticide use, established by Regulation 216 (described in Chapter III), does not specifically prohibit the application of restricted use pesticides in A.I.D. projects. The appropriate chemical is determined by following the EA procedures. In general, however, restricted use pesticides will not be approved, particularly if there is evidence that a safer alternative is available or if a reasonable alternative crop exists that does not require a restricted use pesticide. Additionally, A.I.D. guidelines endorse the FAO pesticide guidelines (Appendix F), which, as stated above, do not approve the use of highly toxic pesticides by small farmers or in countries that have a poorly developed regulatory infrastructure.

## PESTICIDE REGULATION IN DEVELOPING COUNTRIES

Pesticide use is almost always associated with some risk to the user and potentially harmful effects on non-target organisms in the environment. Consequently, effective control over pesticide availability and use is required.

The principle method for controlling the types of pesticides available in a country is by: 1) controlling their importation, manufacture, and sale through a mandatory registration process; and 2) enacting legislation regarding in-country manufacturing and formulation. The purpose of registration is to ensure that pesticides, when used according to label directions, will be effective against the target pest yet not pose unacceptable risk to the user, the general public, or the environment. The determination of acceptable risk is subjective, but should be based on an objective evaluation of the risks and benefits associated with use of the proposed pesticide. The risk/benefit assessment may differ from one country to another. The FAO has developed a set of guidelines for developing appropriate pesticide regulations (see Appendix B, Publication No.2).

A typical mechanism for registering pesticides is to establish a national panel of experts that reviews petitions to import and market specific pesticide products. The panel establishes, either at the outset or gradually, a list of acceptable and unacceptable (banned) pesticides. Developing countries may choose to use or modify lists established by another country. All pesticides should be subject to a review process regardless of whether they are imported or manufactured domestically by the private sector, government agencies, donor organizations, or non-governmental organizations (NGOs). The panel may have the additional task of establishing regulations concerning pesticide labeling, quality control, packaging, storage, transport, disposal, and distribution, and may develop mechanisms for enforcing those regulations.

## HUMAN SAFETY AND AWARENESS

One effective method of mitigating human exposure to pesticides is through public awareness. All pesticide-related programs should consider the need for public awareness programs about pest management activities. Such programs can be carried out through the local extension service or the ministry of agriculture (or its equivalent). Large-scale pesticide operations (e.g., locust plague control) may require media coverage to better disseminate information on the control effort. In addition, systematic monitoring for pesticide exposure (e.g., acetylcholinesterase kits for organophosphate and carbamate pesticides) should be strongly encouraged even though safety measures to protect pesticide applicators and handlers are carried out. Systematic monitoring of the exposure levels of handlers and applicators allows project administrators to determine whether to refine the pesticide application procedures and equipment. Also, pesticide exposure monitoring can indicate in a timely manner which workers are at risk of pesticide intoxification.

## RECOMMENDATIONS FOR HANDLING PESTICIDES SAFELY

### Pesticide Application

-Always read the pesticide label and follow its instructions completely. The label instructs the user about the type of protective clothing to wear and other precautions that will minimize the possibility of negative effects on the user and the environment. Labels should be in the local language(s).

-Wear clean protective clothing and a respirator whenever recommended.

-Never leave pesticides unattended in an unsecured place.

-Never transfer pesticides to containers other than those designed to hold that pesticide.

-Never work alone with pesticides.

-Inspect containers for leaks before manipulating them.

-Keep food, drink, tobacco, and eating utensils away from the work area.

-Never eat, drink, smoke, or rub your eyes when handling pesticides.

-Always have soap and plenty of water available at the work site.

-Thoroughly wash protective clothing after handling pesticides. Wash pesticide-contaminated clothes separately from other clothing. Dispose of any heavily contaminated clothing.

-Workers should immediately stop work and wash if pesticide spills on them.

-Keep unauthorized persons, especially children, away from pesticides.

**Pesticide Storage**

Following proper procedures in storing pesticides protects the product from deterioration and protects the general public and environment from harmful exposure. Pesticide storage procedures should be posted in storage areas in the local language(s).

Nearly all pesticides have a limited shelf life. Even pesticides properly stored in sealed containers will deteriorate over time. The active ingredient can break down into other products that may or may not have pesticidal activity, or the pesticide formulation can break down, making it impossible to use the product. Deterioration is accelerated by both external climatic elements (high temperature, sunlight, and humidity) and internal corrosion of the container by the pesticide.

Liquid formulations in sealed containers typically have a longer shelf life than dry formulations, but their shelf life may decline rapidly once the container has been opened.

Some general recommendations on selecting a site for a pesticide storage warehouse, characteristics of a good storage facility, and pesticide warehouse management are provided below.

<u>The pesticide storage site should</u>

-be far removed from any population centers, both present and future. Site planners should consider urban expansion. Too often, pesticide storage facilities built on the outskirts of a city have been enveloped as the city expands.

-be located in an area not prone to flooding.

-be inaccessible to any nearby surface water source or located in an area that has a high water table.

-afford good access, preferably from more than one side, for delivery trucks and fire-fighting vehicles.

-be shaded by trees, if possible, to help lower the temperature in the warehouse.

-be fenced and posted with warning signs to keep out unauthorized individuals, domestic animals, and wildlife.

<u>The pesticide warehouse or storage shed should</u>

-be built of non-flammable materials such as cement blocks or corrugated metal sheeting.

-have floors made of smooth concrete or other impervious material so that pesticide spills will not be adsorbed.

-be well-ventilated, preferably by natural wind flow, to minimize temperature increases and keep fumes from accumulating.

-be surrounded by a ditch to keep any liquid spills from draining away from the warehouse.

-be constructed to allow tight security (locking doors, barred windows).

-be well-lit either by sunlight or electric lights.

-have a water supply for spill decontamination.

-display instructions on managing spills in the local language(s).

-be equipped with spill containment and safety supplies (e.g., shovels, sand, brooms, hoses, fire extinguishers).

The warehouse should be managed so that

-A "first in-first out" procedure is followed for all pesticides, to minimize the chance for deterioration of the product and containers.

-Individual products are stored separately, and aisles are located so that all products can be accessed.

-All pesticides are kept on pallets. This allows easier manipulation and keeps containers from contact with moisture on the floor, which leads to more rapid deterioration of containers.

-No food, tobacco, or drinking water is stored in the warehouse.

-No eating, drinking, or smoking is allowed in the warehouse.

-A supply of soap and water for washing in maintained in the warehouse.

-If possible, herbicides are stored separately from insecticides and fungicides, to avoid cross-contamination if herbicides leak or are spilled.

**Pesticide Transport**

Because of their hazardous nature, pesticides must be transported with special care. This may be especially important in developing countries where roads are often in poor condition. Listed below are some guidelines for the transport of pesticides:

-Use well-maintained vehicles to avoid accidents and delays.

-Use open vehicles covered with tarpaulins to decrease any possible build-up of heat or toxic vapors and to protect the pesticide from rain.

-Make sure that drivers are aware of the dangers associated with the materials they are transporting and have the training necessary to handle spills.

-Vehicles transporting pesticides should never be left unattended.

-Containers should be well secured in the bed of the vehicle with ropes, chocks, etc.

-Never transport leaking or badly deteriorated containers; transfer the pesticide to structurally sound containers or place damaged containers in "overpack" drums.

-Make sure that all containers are labeled with appropriate warnings.

-Do not transport food, beverages, animal feed, or clothes with pesticides.

-Load and unload pesticides very carefully to minimize the chance of dropping containers. If no loading ramp or hoist is available, pesticides can be off-loaded by rolling containers onto used tires.

-Thoroughly wash the vehicle after unloading. Any spilled pesticide should be absorbed with sand, sawdust, ash, or dirt and decontaminated with a neutralizing compound such as bleach.

**Pesticide Spills**

-The type of chemical spilled should be identified as soon as possible, and the source of the spill should be stemmed. All personnel dealing with spills should wear protective clothing, including respirators.

-The dimensions (area and depth) of the chemical spill should be determined. This may require laboratory analyses of soil samples obtained with a soil core sampler.

-Risks of contaminating water, food, fuel, other chemicals, humans, and other organisms should be assessed, and items at risk should be removed, if possible.

-Superficial spills involving organophosphate pesticides can be neutralized using lime. All spills should be isolated as soon as possible. Heavily contaminated materials, including soil, can be disposed of using methods prescribed in the following sections.

## DISPOSAL OF PESTICIDES AND EMPTY CONTAINERS

One of the most difficult problems associated with pesticide use is the management of unwanted pesticide and empty containers. "Unwanted pesticide" can refer to the product left over in a spray tank after application, to rinsate from the "triple rinse" procedure (described below), or to obsolete pesticide that can no longer be used because of deterioration or legal restrictions (e.g., the pesticide was banned after it was procured). In addition, all program that use pesticides must manage the disposal of empty pesticide containers.

In general, the manufacturer of the unwanted pesticide(s) should be contacted for information on the compound prior to planning for specific disposal options. In some cases, the manufacturer may be willing to participate in the disposal or containment of the unwanted stocks.

**Empty Containers**

Pesticide containers can never be completely cleansed of pesticide residues. Therefore they should never be used for storing food or water. Avoiding reuse is a particularly acute problem in developing countries where any kind of container, especially high-quality steel drums, is in high demand for storage and construction. Only two procedures can ensure that empty pesticide containers are not used for food or drinking water: 1) render the containers unusable or 2) return them to a formulation facility for reuse.

Following are some general procedures for dealing with empty containers.

**Draining**--Drain the container for at least 30 seconds into the spray tank or other container (for liquids).

**Cleaning**--Clean the container by one of two methods:

o Triple rinsing with an appropriate solvent. This procedure involves adding a solvent equal to approximately 10% of the container's volume. The solvent should be water for water soluble formulations (e.g., emulsifiable concentrates and flowables) or an organic solvent, such as diesel fuel, for ULV and other petroleum-based formulations. After the solvent is added, the container is agitated and the rinsate drained into an appropriate recipient (spray tank or other). This procedure is repeated three times. The triple rinse has the disadvantage of resulting in large quantities of dilute pesticide, which must be considered a hazardous waste and handled appropriately.

o Treating the empty container with a combination of chemicals to neutralize the pesticide residues. For most organophosphate and carbamate insecticides, an alkaline substance such as lye or bleach helps break down most of the remaining pesticide. Specific recommendations are available from pesticide manufacturers.

**Disposal**--Dispose of the container by one of three methods:

o Burial. Containers (metal, glass, or paper) should be buried in a shallow pit (2 feet deep) at a site that meets the criteria for a pesticide storage site, listed above. Burial in soil that contains a high proportion of clay and organic matter is best because it decreases leaching and accelerates microbial breakdown. The site should be fenced, with warning signs posted. Geologic and hydrologic evaluation of potential burial sites should be conducted before the construction of burial pits to ensure that conditions are appropriate for this method of disposal. Accurate records should be kept of the number and kinds of containers buried at a particular site.

o Return the container to a pesticide formulation facility. This option should be selected only after a careful evaluation has shown that the facility will properly recondition containers before reuse. Reconditioning includes thorough cleaning, relining, painting, and relabeling. Normally this option will be available only for large steel drums.

o Sell the containers for recycling. This option may be available for steel containers in certain countries. Smelting temperatures, which normally reach 2000° F, will consume any remaining pesticide. Containers should be pierced and crushed prior to recycling.

**Destroying the container**--Containers can be destroyed by piercing, crushing, or (if glass) breaking. Options for the ultimate disposal of containers are still being explored by A.I.D., other donors and international organizations.

**Unwanted Pesticide**

Unwanted pesticide comes in two general forms: (1) quantities left over after application or container rinsing and (2) obsolete pesticides that are no longer of use. Pesticides left over in the spray tank after application and rinsates can be dealt with fairly easily. The pesticide can be sprayed out in the same area that received the application or in an area similar to it, or, if undiluted, it can be returned to the original container for storage until later use. **Note:** Rinsates that are based on organic solvents may be phytotoxic (i.e., toxic to plants).

Disposal of large quantities of obsolete pesticide is a more difficult and potentially dangerous problem. To minimize the possibility of such disposal problems, never plan to purchase or store more pesticide than will be needed during one control season.

Disposal of obsolete pesticides can be adequately addressed only on a case-by-case basis. Nevertheless, following are some general issues for consideration:

-Why is the pesticide unwanted? This could be due to either deterioration or regulatory measures (banning its use in a country). If the pesticide is unwanted because of deterioration, how has this been ascertained? Has an analysis been conducted to determine whether the product can still be used.? If not, this may be a useful first step.

-If the pesticide is still usable, is there an alternate use for it? For example, can a pesticide imported for locust control be appropriately used against some other pest after the locust threat has abated?

-What is the condition of the containers? The situation is more urgent if the containers are showing signs of losing structural integrity than if they are still intact. An interim measure to prevent leakage from deteriorating containers is to repackage the pesticide in new containers or place the old containers in "overpack" barrels.

-How much and what kind(s) of pesticide(s) are unwanted? A detailed inventory is needed before appropriate disposal plans can be developed.

The disposal of obsolete or unwanted pesticides is a complex and potentially hazardous undertaking that can also be expensive if quantities are large. Again, each disposal problem is unique, and the capabilities and facilities for disposal vary among countries. **Always seek expert advice whenever A.I.D. is considering involvement in a pesticide disposal operation**. The USEPA often provides technical assistance to A.I.D. on pesticide disposal on several occasions. An EA will be required before A.I.D. involvement can be initiated. Following are brief descriptions of some of the options that may be available for pesticide disposal (the ordering of the options is not an indication of preference).

<u>Dedicated Incinerator</u>

High temperature incineration at a facility specially built for burning hazardous waste is one method for disposing of large quantities of unwanted pesticides. Few developing countries have dedicated hazardous waste incinerators, however, and such facilities are very expensive to build. It may be possible to transport unwanted pesticides to an incinerator in another country, although there may be legal constraints on the movement of hazardous waste across borders.

Return to a Formulation Facility for Reformulation

Reformulating a pesticide may be a valid, though untried, alternative in certain limited situations, particularly if the country where the pesticide is located has a pesticide formulation facility. In principle, the formulation facility could transform the product into a more useful form; for example, a ULV formulation procured for locust control could be reformulated into an emulsifiable concentrate for use in vegetable gardening. It may also be possible to transport the pesticide to another country for reformulation. This may be difficult, however, especially for landlocked countries, due to legal constraints on transport, cited above.

Incineration in a Cement Kiln

Experiments have shown that pesticides can be decomposed by burning (as fuel) in a modified cement kiln. The advantage of this method is that many countries already have cement kilns. The cement factory must be a modern facility in good working order, however, before this option can be considered. In late 1989, A.I.D. modified a cement kiln in northern Pakistan and burned unwanted pesticides, including dieldrin, with emissions rates that approached those set by the USEPA. Further testing of this method may result in an environmentally acceptable method for pesticide disposal. A technical report on this experiment is available from the Office of U.S. Foreign Disaster Assistance (OFDA) in AID/W.

Land Farming

Land farming refers to applying the pesticide to unused land. This option can be used only for pesticides that are rapidly broken down by the combined action of sunlight (photodecomposition) and soil microbes. In most cases, land farming should be considered a last-resort option. The procedure requires that safety precautions be built into the operation and identified in a comprehensive EA.

Biodegradation

Biodegradation refers to the use of microorganisms to break down a pesticide into non-toxic compounds. At present, biodegradation is primarily used for on-farm disposal of excess diluted pesticide and rinsates. Microbial action is favored by a high organic content at the disposal site. Nitrogen fertilizers, animal manure, and compost can be added to increase microbial activity. Future work is likely to focus on artificially selecting or genetically engineering organisms to more effectively decompose pesticides.

Chemical Decomposition

Experimental work has been conducted on chemical detoxification of pesticides. This technique is still in a research phase.

# CHAPTER VI
# EMERGENCY OPERATIONS AND DISASTER DECLARATIONS

Many pest species go through periodic changes in abundance. Typically, these oscillations in density are in response to changes in the climate or other external factors. When rainfall is sufficient in certain critical geographic areas, populations increase in response to favorable ecological conditions. Major plagues occur when favorable conditions coincide temporally and spatially with traditional breeding areas for two or three consecutive years. In periods of high density, the threat of damage to crops, livestock, wildlife, or humans can reach emergency proportions; desert locusts in Africa and Asia are a good example of this phenomenon.

Introduction of a pest to an area of the world it did not formerly inhabit can also pose a serious threat to the welfare of the area's inhabitants. If the potential for negative impact is determined to be high, an effort to eradicate the pest before it becomes widely distributed may be the most sensible action. This could also be considered an emergency operation.

The objective of this chapter is to provide guidance to A.I.D. Missions and Bureaus in emergency situations such as those described above. The majority of A.I.D. acute emergency pest management activities have involved grasshoppers and locusts in Africa and Asia. The experiences gained from these control activities and the policies governing A.I.D. operations in emergency situations have application to other pest emergencies. This chapter summarizes some of the information contained in A.I.D. Locust/Grasshopper Management Operations Guidebook (Appendix B, Publication No.17), and that document should be referred to for greater detail.

## DEFINITIONS

### Pest Emergency

A pest infestation is determined to be an **emergency** when the threat of damage is great and when the ability of the host country to deal effectively with the problem is surpassed or is likely to be surpassed in the near future. The decision of whether any given infestation is an emergency is technical in nature and depends on the biology of the pest, the potential for injury to crops, livestock, humans, or wildlife, and the ability of the affected country or countries to handle the problem effectively.

### Pest Disaster

The term **disaster** is restricted to situations where the U.S. ambassador of a country, in response to the host country's request and in consultation with A.I.D. officials and other sources of information, has determined that the urgency of a pest situation merits declaration of a disaster. A disaster determination is made in response to the following:

1.a violent act of nature, such as flood, hurricane, fire, earthquake, volcanic eruption, or landslide;

2.an act of man, such as civil strife, border conflict, riot, or displacement of large numbers of people;

3.an accident of serious proportions, such as an explosion or fire;

4.a slowly developing catastrophe caused by nature or human neglect, or both, such as drought, famine, or epidemic; or

5.a potential calamity, including ecological threats, menacing lives and property and requiring prevention or monitoring measures.

Pest disasters could be included under criteria 4 and 5. (Chapter 3, A.I.D. Handbook 8).

## FORECASTING DISASTERS/EMERGENCIES

Today's surveillance systems (e.g., greenness/biomass indicators, computer modeling of pest populations, crop-yield forecasting, and information acquired from satellite imagery), in conjunction with traditional survey methods, can help us predict emergencies that could develop into catastrophes. In the future it should become increasingly possible to respond to an emerging pest problem before it becomes a disaster, thereby avoiding undue harm to the environment and waste of resources. A.I.D. should encourage host countries to conduct timely and systematic pest surveys, supplemented by appropriate modern technology, to forecast and prevent impending pest emergencies and disasters.

## PEST CONTROL OPERATIONS

The primary responsibility for managing pest infestations rests with the government within the affected country. In many countries a national crop protection service operates under the ministry of agriculture (or its equivalent) to address pest infestations affecting agricultural crops. Pests of livestock are generally handled by animal health personnel (also generally within the ministry of agriculture), while human health vectors are the responsibility of units within the ministry of health. These services are sometimes supported by regional organizations that provide services to member countries.

When the host country government is no longer able to respond effectively to a pest problem and requests assistance from the donor community, the U.S. government (USG) may support preparedness or control operations on an emergency or non-emergency basis. Under the authority of A.I.D. Handbook 8, the Office of U.S. Foreign Disaster Assistance (OFDA) will provide funds to countries suffering serious pest infestation when a disaster determination is made by the U.S. ambassador. A.I.D. Bureaus or Missions may provide support for bilateral or regional pest management programs on a non-emergency basis.

### Foreign Disaster Relief

In the event of a declared disaster, as defined in A.I.D. Handbook 8, the United States may provide emergency relief assistance as a humanitarian service consistent with U.S. foreign policy goals. Assistance shall, to the greatest extent possible, reach those most in need of relief and rehabilitation. U.S. assistance supports and encourages host country participation in disaster preparedness activities and supplements rather than replaces host country disaster relief resources.

Normally, disaster relief can be made available during the initial 60-day period following the sudden onset of a disaster. During this period, the Chief of Mission may commit up to $25,000. Commitments in excess of the initial $25,000 and/or extension of the disaster phase beyond 60 days require prior approval of OFDA. Missions should submit detailed budgets and Action Plans for OFDA review. OFDA assistance to pest control programs may consist of technical assistance, contracting of aircraft, and the purchase of pesticides and equipment.

### Response Coordination

A.I.D. gives a high priority to joint donor participation and international coordination of all aspects of pest control programs. A.I.D. will participate in host country planning committees with other donor and international organizations and host country officials, as well as in donor meetings sponsored by FAO or other international organizations coordinating pest control efforts. A.I.D. will provide resources in response to country action plans approved by Country Coordinating Committees. The U.S. government may also make contributions to international organizations handling pest control programs. Contributions to an international organization do not preclude the USG from providing relief for the same disaster on a bilateral basis.

**Continuing Crop Protection Responsibility**

A.I.D. believes that, over the long term, national and regional crop protection groups must ultimately address the pest control problems in developing countries.

A.I.D. will provide medium to long-term bilateral resources from geographic Bureaus or Mission funds, if available, for host country institutional development when A.I.D. operational plans demonstrate that marginal contributions to specifically identified activities will increase the host country's or regional organization's ability to handle pest control. A.I.D.'s support for this type of institution building follows the normal process for project development.

**USG Environmental Regulations**

Disaster and emergency assistance programs for pest control often involve the procurement and use of pesticides. A.I.D. requires that these programs adhere to Regulation 216 in the choice, use, and handling of pesticides. In emergency or disaster situations, a waiver to Regulation 216's requirement for an EA may be granted; however, it is A.I.D.'s policy that an EA will be started immediately and its recommendations incorporated into the relief operation as soon as the are identified. In the case of grasshopper/locust outbreaks in Africa and Asia, a Programmatic Environmental Assessment (PEA) was prepared and approved within A.I.D. to guide A.I.D. assistance, including the selection of appropriate pesticides.

In general, only pesticides registered for use by the USEPA are recommended. Also, to the extent possible, pesticides should be purchased from U.S. sources. Any Mission planning to provide future assistance for locust and grasshopper control must prepare a country-specific EA or supplemental (to the PEA) EA prior to approval of any control programs. EAs exist for locust and grasshopper control in Morocco, Pakistan, and Tunisia, and for screwworm prevention in Egypt. Supplemental grasshopper/ locust EAs are expected to be completed for Chad, Mali, Niger, Mauritania, Senegal, Cameroon, Burkina Faso, and Sudan.

Missions that become involved in programs that require the purchase or use of pesticides should become familiar with the USG regulations on pesticides as soon as possible after a potential disaster has been identified (see Chapters I and III). Pesticide use, storage, disposal, training of applicators, and the provision of protective clothing must be considered at the outset of the decision to provide emergency assistance (see Chapter V for additional information on pesticide management).

**Environmental Impact**

A.I.D. policy on the use of pesticides, as discussed in Chapter I, is to: 1) strengthen the host country's capacity to appreciate and evaluate the potential environmental effects of the pesticides; 2) select and implement measures to manage the environmental effects effectively; and 3) promote IPM to the maximum extent possible.

A.I.D. will support pesticide residue testing and analysis to evaluate the environmental effects of pesticides used in pest control operations. Environmental safeguards must be integrated into all pest control operations, especially emergency pest control operations, from inception to the end.

**Avoiding Excess Pesticide Stocks**

During emergency situations, it is often difficult to determine the exact quantities of resources needed to meet the emergency. This is particularly true for pest infestations, which can rapidly increase or decrease in importance. A.I.D. policy discourages the stockpiling of pesticides for emergency operations.

Instead, A.I.D. encourages the setting up of "pesticide banks" through prior arrangements with manufacturers. Pesticide banks are a means of guaranteeing the availability of specific pesticides for delivery on short notice. The principle is to avoid--to the extent possible--speculative pre-positioning of large quantities of pesticides in the outbreak region. This approach is amply supported by a past history of large quantities of obsolete pesticides remaining from earlier campaigns, which also raises the problem of disposal.

A.I.D. policy also encourages host country governments to avoid storing more pesticide than can be used in one season's control campaign. Missions should explore the willingness of the host country government to donate unused pesticides to neighboring countries in need or to consider alternate applications within the country, according to label directions.

**GUIDELINES FOR ACTION IN PEST DISASTERS**

1. **Prepare a disaster determination**. The disaster determination must be prepared before any OFDA funds can be made available to the country. A disaster determination should contain the specific information required by OFDA (available in A.I.D. Handbook 8).

2. **Assign an action/project manager**. Initiate emergency operations procedures such as reassignment of additional staff, establishment of a filing system, and request for a shorter cable approval process. Organize a mission disaster committee following the Mission disaster plan. Members may be representatives from the director's office, a technical office, a management office, the controller's office, and the program office.

The committee should address the following questions:

-Are the Mission's resources adequate?

-What external assistance is needed to manage the program effectively (entomologist, logistician, coordina tor)?

3. **Develop a budget and Plan of Action for submission to OFDA**. If dollar values are unknown, indicate the kinds of services and commodities required. The possibility of using local currency for disaster programs can be considered.

4. **Establish procedures for Mission management of finances and funds disbursal**.

5. **Discuss the type and formulation of pesticides currently in the country and propose the choice of pesticide for procurement based on the PEA or other A.I.D. guidance**. To achieve the most effective mobilization and allocation of resources within the donor community, note the cable 88 STATE 339983 (18 Oct 88) on "Further guidance on participation in locust control campaigns that may utilize non-approval pesticides" (Appendix B, Publication No.22)

6. **Decide who will procure the needed commodities**--the Mission, OFDA, the host country, or another mechanism. In disaster situations, OFDA can procure and ship commodities very rapidly.

7. **Initiate numbered situation reports to be submitted regularly to AID/W**. OFDA should be designated as the action addressee, with information copies to other interested offices (Geographic Bureau Technical Resources Divisions). Cooperating European capitals (e.g., Rome for FODAG, Paris for Club du Sahel, Brussels for USEC, Abidjan for REDSO and APHIS), neighboring countries and other potentially

affected Missions should also be included in the distribution. The reports should contain the following information:

-Recent information concerning movements and control operations

-Logistic operations

-Finances

-Donor coordination/pledges

8. **Maintain records**. Maintain records of the arrivals/ departures of technical assistance teams, the dates and contents of significant decisions, the general chronology of events, and the contributions of all donors. These records will be useful in preparing a final report for OFDA, which should include a section on success, failures, and lessons learned.

9. **Make Mission resources available as appropriate, especially for short-term technical assistance**. Mission resources include vehicles, camping equipment, international and internal travel arrangements and clearances, interpreting/ translating services, maps, and secretarial services.

10. **Obtain briefing materials on the pest situation to facilitate Mission orientation to the problem**.

11. **Use the telephone as necessary to ensure prompt disaster response**. All information communications should be confirmed by cable, however.

12. **Plan for the following activities:** survey, procurement, personnel, transport, equipment, field communications, control activities, customs clearance, training, funding, and environmental impact assessment and evaluation. Environmental impact assessments should be in place prior to assistance implementation, or the process could be delayed.

13. **Develop an organizational chart.** Delineate lines of responsibility within the Mission.

14. **Establish a logistics plan, a field support plan, and communications systems.**

15. **Plan for communications media coverage to educate the public about the program.** Communities near the area(s) of operations should be particularly aware of needed safety precautions.

**References Cited**

A.I.D. 1978. Policy on Pesticide Support. A.I.D., Washington, D.C.

A.I.D. 1981. A.I.D. Environmental Procedures, 22 CFR Part 216. Washington, D.C.

A.I.D. 1983. A.I.D. Handbook 8. A.I.D., Washington, D.C.

A.I.D. 1988. A.I.D. Policy Paper: Environment and Natural Resources. A.I.D., Washington, D.C.

A.I.D. 1989. Locust/Grasshopper Management Operations Guidebook. A.I.D., Washington, D.C.

Bottrell, D.G. 1979. Integrated Pest Management. Council on Environmental Quality, U.S. Government Printing Office, Washington, D.C.

FAO/UNEP. 1967. Integrated Pest Control: An Introductory Statement from the FAO/UNEP Panel of Experts on Integrated Pest Control. FAO, Rome, Italy.1

# Appendix A

## Regulation 216

Appendix B

REFERENCES AND SOURCES OF INFORMATION

**Selected Publications:**

1. Food and Agriculture Organization of the United Nations (FAO). FAO Plant Production and Protection Paper series of guidelines for the integrated control of crop pests (rice, corn, etc.). When ordering, indicate the crop of interest.

Publications Division
FAO, Via delle Terme di Caracalla
00100 Rome, Italy.

2. Food and Agriculture Organization of the United Nations (FAO). Guidelines on:

a. The Registration and Control of Pesticides.
b. Good Labeling Practices for Pesticides.
c. The Packaging and Storage of Pesticides.
d. Pesticide Residue Trials to Provide Data for the Registration of Pesticides and the Establishment of Maximum Residue Limits.
e. Environmental Criteria for the Registration of Pesticides.
f. Efficacy Data for the Registration of Pesticides for Plant Protection.
g. The Registration of Biological Pest Control Agents.
h. Retail Distribution of Pesticides with Particular Reference to Storage and Handling at the Point of Supply to Users in Developing Countries.
i. Post-Registration Surveillance and Other Activities in the Field of Pesticides.
j. The Disposal of Waste Pesticide and Pesticide Containers on the Farm.
k. Good Practices for Ground and Aerial Application of Pesticides.
l. Government Responsibilities in Implementing the Pesticide Code of Conduct (draft, to be published in 1991).
m. Personal Protection When Using Pesticides in Hot Climates.
n. Legislation on the Control of Pesticides.
o. Disposal of Bulk Quantities of Unwanted Pesticides (to be published in 1991).
p. Pictograms for Use on Agrochemical Labels.

The above publications may be ordered individually or as a set. See the address above.

3. Formulation of Pesticides in Developing Countries. United Nations Industrial Development Organization. Vienna, 1983.

4. Recognition and Management of Pesticide Poisonings. United States Environmental Protection Agency (USEPA). 4th edition, 1989. Available in English and Spanish.

S&T/AGR
Agency for International Development
Washington, D.C. 20523

5. An Agromedical Approach to Pesticide Management: Some Health and Environmental Considerations. Davies, J.E., Freed, V.H., and Whittemore, F.W., A.I.D./CICP/University of Miami, 1983.

S&T/AGR
Agency for International Development
Washington, D.C. 20523

6. Guidelines for the Safe and Effective Use of Pesticides.
(Published in several languages)

International Group of National Associations of Manufacturers of Agrochemical Products (GIFAP)
Avenue Hamoir 12
1180 Bruxelles, Belgium

7. Work Smart, Work Safely, with Farm Chemicals. (Published as a pictorial guide for farm workers in English and Spanish)

National Agricultural Chemicals Association (NACA)
1155 Fifteenth Street, N.W.
Washington, D.C. 20005

8. Field Surveys of Exposure to Pesticides - Standard Protocol. World Health Organization, 1981.

Pesticide Development and Safe Use Unit Division of Vector Biology and Control
WHO Headquarters
1211 Geneva 27, Switzerland

9. Agro-pesticides: Their Management and Application. Oudejans, J.H., United Nations Economic and Social Commission for Asia and the Pacific, 1982.

10. Handbook on the Use of Pesticides in the Asia-Pacific Region. Asian Development Bank, 1987.

Information Office
Asian Development Bank
P.O. Box 789
Manila, Philippines

11. Integrated Pest Management. Council on Environmental Quality, 1979.

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

12. Integrated Pest Management, 1982 ($7.50); Resistance of Agricultural Pests to Control Measures, 1983 ($2.50). Council for Agricultural Science and Technology (CAST).

CAST
137 Lynn Avenue
Ames, Iowa 50010

13. Manual for Preparation of Initial Environmental Evaluations (IEE) and Environmental Assessments of USAID Projects for the Control of Vector-borne Diseases. 1990.

S&T/HP/P

Agency for International Development
Washington, D.C. 20523

14. Pesticide Users Guide. A Handbook for African Extension Workers. Overholt, W. and Castleton, C., 1989.

AFR/TR
Agency for International Development
Washington, D.C. 20523

15. Farm Chemicals Handbook
(issued annually)
Meister Publishing Company
37733 Euclid Ave.
Willoughby, Ohio 44094

16. Suspended, Cancelled, and Restricted (SCR) Pesticides. USEPA Registration Support Branch, Office of Pesticide Programs. February 1990.

17. A.I.D. Locust/Grasshopper Management Operations Guidebook. 1989.

AFR/TR
Agency for International Development
Washington, D.C. 20523

18. U.S. Code of Federal Regulations Title 40. 1988.

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402-9325

19. Regional Agro-Pesticide Index. 1990. CIRAD. Three volumes: (1) Asia, (2) Pacific, (3) Africa.

Franco-Pacific
8th floor, Mahatun Plaza
888/88 Ploenchitr Road
Bangkok 10500, Thailand

20. Food Chemical News. (Journal subscription).

1101 Pennsylvania Avenue, S.E.
Washington, D.C. 20003

21. Pesticide and Toxic Chemical News. (Journal subscription).

1101 Pennsylvania Avenue, S.E.
Washington, D.C. 20003

22.Further guidance on participation in locust control campaigns that may utilize non-approval pesticides, Cable 88 State 339983 (18 Oct. 88)

**Resource Contacts:**

1. AID/Washington Operations Bureaus:
Africa, Asia, Europe, Latin America and Caribbean, Near East, Office of Foreign Disaster Assistance, Research and Development (S&T)--Environmental Coordinator and Pest Management Advisors

2. National Pesticide Information Retrieval System (NPIRS)
Purdue University
Entomology Hall, Room 220
West Lafayette, IN 47907
Tel: (317)-494-6614
Fax: (317)-494-0535

NPIRS, the "clearinghouse" for USEPA information on pesticides, maintains both an on-line information retrieval service and data bases on CDROMs. These (PEST-BANK and CHEMBANK) are updated quarterly and accessible free of charge to A.I.D. Missions and Bureaus through CICP (see above). On-line service is updated weekly and coverage is somewhat more extensive. NPIRS should be contacted for current subscription costs.

3. Food and Agriculture Organization of the United Nations (FAO)
Plant Protection Service
Plant Production and Protection Division
Via delle Terme di Caracalla
00100 Rome, Italy
Tel: 57975757
Telex: 61081 FAO 1
Fax: 5646172

4.U.S. Environmental Protection Agency (USEPA)
Office of International Activities (A-106)
401 M. Street, S.W.
Washington, D.C.
Tel: (202)-382-4878
Fax: (202)-382-7883
Tlx: 892758USEPA WSH

5. National Pesticides Telecommunications Network (NPTN)
Texas Tech University
Health Science Center
Department of Preventative Medicine
Lubbock, TX 79409
Tel: 1-800-858-7378

Supplies information on pesticide safety and human poisoning. Funded by USEPA.

6. Denver Wildlife Research Center (DWRC)
International Programs Research Section
Building 16, Denver Federal Center
P.O. Box 25266
Denver, CO 80225-0266
Tel: (303) 236-7850

Fax: (303) 236-7863

Supplies information on control of vertebrate pests, e.g., birds and rodents. An activity of USDA; special project funding by A.I.D.

7. International Group of National Association of
Manufacturers of Agrochemical Products (GIFAP)
Avenue Hamoir 12
1180 Bruxelles, Belgium

Supplies information on pesticide manufacturers, safe handling, application equipment and farmer training.

8.World Health Organization (WHO)
1211 Geneva 27
Switzerland

Supplies information on pesticide issues related to human health.

9. Pan American Health Organization
525 23rd St., N.W.
Washington, D.C. 20036
(202) 861-3200

# Appendix C

## Summaries and Tables of Contents of Selected Environmental Reviews

Appendix D

Manual for Preparation of Initial Environmental Examination (IEE) and Environmental Assessment (EA) of U.S.A.I.D. Projects for the Control of Vector-Borne Diseases

Appendix E

MAJOR CHEMICAL GROUPS AND FORMULATIONS OF PESTICIDES

**Chemical Groups**

Insecticides

Chlorinated hydrocarbons: Most insecticides in this group are very persistent in the environment, are not readily metabolized by most living organisms, and are fat soluble. Because of these properties, the chlorinated hydrocarbons are able to accumulate in animals, and they bio-magnify, i. e., they move through the food chain with each level having a higher concentration. The acute toxicity of chlorinated hydrocarbons ranges from highly toxic to moderately toxic. Many countries have banned or severely restricted the use of chlorinated hydrocarbons because of their long-term environmental impacts. Common insecticides found in this group are DDT, BHC, lindane, and dieldrin.

Organophosphates (OPs): These insecticides vary from highly toxic to relatively nontoxic. They do not persist in the environment, generally lasting less than one month before breaking down into nontoxic substances. However, the affects of organophosphate pesticides on animals (including humans) can accumulate. Organophosphates inhibit an enzyme, acetyl-cholinesterase, necessary for nerve transmission. This affect is non-reversible, and therefore the body must produce more of the enzyme to replace that which has been affected by the pesticide. If a person is repeatedly exposed to organophosphate pesticides, the body cannot replace the enzyme as fast as it is being destroyed and the person can suddenly become ill after an exposure that taken alone would not be sufficient to cause intoxication. Examples of commonly used organophosphates are malathion, fenetrothion, and chlorpyrifos.

Carbamates: This group of insecticides has properties similar to the organophosphates. Carbamate insecticides break down readily in the environment and have a wide range of acute mammalian toxicity. The carbamates differ from the organophosphates in that the affects on the nervous system are rapidly reversible, and therefore not cumulative.

Synthetic pyrethroids (SPs): This is a relatively new group of insecticides and their use is increasing. The synthetic pyrethroids are chemicals synthesized by man to resemble a naturally occurring insecticide found in the flowers of certain plants in the genus Chrysanthemum. In general, synthetic pyrethroids are very toxic to insects but much less toxic to mammals. Some of the synthetic pyrethroids are highly toxic to fish and should be used with great care near bodies of water. Because of their high toxicity to insects, they are typically applied at much lower rates than any of the above-mentioned groups. Examples of synthetic pyrethroids in common usage are Karate (lambda-cyhalodrin) and Decis (deltamethrin).

Insect Growth Regulators (IGRs): These are chemical substances that disrupt the normal development of insects (and other arthropods), rather than acting on the nervous system as do the chemical groups listed above. IGRs are generally nontoxic to vertebrates, mollusks, and plants. The IGRs presently in use include chitin synthesis inhibitors (e.g., diflufenzuron) which interfere with the production of the insect cuticle, and juvenile hormone analogues (e.g., methoprene) which disrupt metamorphosis.

Biological Insecticides: These are usually microbial agents formulated for application by conventional methods. They are generally quite selective against the target pest (little or not effects on non-target organisms). The microbial agents include viruses (e.g., nuclear polyhidrosis viruses for control of certain moths, especially in forested lands), bacteria (e.g., Bacillus thuringiensis and B. popilliae against a wide variety of pests insects), fungi (some are known to be effective against plant-parasitic nematodes in orchard situations), protozoa (e.g., Nosema locustae against various locusts and grasshoppers), fungi, and nematodes (certain species have been shown to be effective against mosquitoes). Many potentially effective biological insecticides are known, but relatively few are being marketed at the present time. Nevertheless, research on them continues.

Other biological pesticides would include microbial toxins, or antibiotics, such as streptomycin and related compounds which are used to some extent to combat pathogens that infect trees. The trees are usually inoculated with the antibiotics using a gravity injection system.

## Herbicides

Phenoxy compounds: Most of the herbicides in this group are used to control broad-leaf weeds. The phenoxy herbicides are analogues of natural plant growth hormones and thereby disrupt normal growth. Although phenoxy herbicides generally have low toxicity to mammals, they can be irritating to the eyes, skin, respiratory, and gastrointestinal linings. Examples of common herbicides in this group are 2,4-D and 2,4,5-T.

Ureas: This group includes herbicides that generally have low selectivity (i. e., affect most plants) which inhibit the metabolic processes of plants. Mammalian toxicity is generally low. Diuron, linuron, and neburon are examples of urea herbicides.

Triazines: These are selective herbicides that are used to control both broad-leaf and grass weeds. The triazines are powerful inhibitors of photosynthesis, but some plants, such as corn, are able to tolerate the triazines more than others. They have low toxicity to mammals. Simizine and atrazine are examples of commonly used triazines.

Dipyridyliums: This group consists of herbicides that are typically non-selective. The dipyridyliums compounds are used for complete weed control of as pre-harvest aids to desiccate the crop plants. Dipyridyliums, unlike many of the other herbicides, are very toxic to mammals when ingested; thus great care should be exercised in the handling and storage of herbicides in this group. Examples of herbicides in this group are paraquat and diquat.

## Fungicides

Inorganic compounds: Some of the earliest pesticides were compounds containing sulfur or copper or mixtures of sulfur and copper, and many of these inorganics are still used as fungicides and acaracides. Generally, the inorganic compounds based on copper and sulfur compounds are relatively nontoxic but may irritate the skin and eyes. Bordeaux mixture (a mixture of copper sulfate and lime) is an example of an inorganic compound used to control several plant fungal diseases.

Dithiocarbamates: Zinc, manganese, and iron salts of dithiocarbamates are widely used as agricultural fungicides. The group has low acute toxicity to mammals but their chronic affects as carcinogens is being questioned. Examples of dithiocarbamates are thiram, maneb, and zineb.

Miscellaneous organics: The chemistry of fungicides does not allow separation of products into a few chemical groups. Other than the dithiocarbamates, two of the most widely used fungicides are captan and daconil. Both are wide-spectrum products that are only slightly toxic to mammals, but can cause skin and eye irritation.

## Rodenticides

Anticoagulants: Many of the commonly used rodenticides kill by inhibiting blood clotting. Exposed animals generally die of internal bleeding. Concentrated formulations are highly toxic but low concentrate ready-to-use products generally available on the market are much less hazardous. Vitamin K is an antidote for poisoning by anticoagulants.  Warfarin and diphacinone are examples of commonly used anticoagulant poisons.

Acute poisons:  A few products are available that are designed to rapidly kill rodents soon after ingestion. Zinc phosphide and arsenic trioxide are inorganics that are both highly toxic to mammals and should be used with great care.  A plant extract, red squill, is also used as an acute poison against rodents.  It is less hazardous to man and other mammals than the inorganic rodenticides because it rapidly induces vomiting (rats cannot vomit).

**Formulations**

Dusts:  Pesticide dusts are an active ingredient combined with an inert powder such as talc or clay.  The percentage of active ingredient is generally quite low.  Dusts are ready to use as purchased and usually safer than liquid formulations for the applicator.  Because of their low concentration of active ingredient, dusts tend to be more expensive than more highly concentrated formulations.

Granules (G):  Granular formulations are similar to dusts except that the particle size is much larger. Granular pesticides are produced by coating or impregnating sand or clay with the active ingredient.  They require no additional mixing and can be applied with simple equipment.  Granules are relatively safe for the user and do not drift from the target site.  Some granular pesticides are systemic, i. e., they are transported through the plant's vascular system.  As with dusts, the concentration of active ingredient is low, and therefore the cost of granular formulations is higher than the cost of more concentrated formulations.

Baits:  A pesticide bait is a mixture of pesticide and a food substance that will attract and be eaten by the target pest.  In general, baits have less impact on non-target organisms than other types of formulations.

Wettable powders (WP):  Superficially, wettable powders appear to be similar to dusts.  However, the concentration of active ingredient is much higher because wettable powders are designed to be diluted in water before application.  Agitation is necessary to keep wettable powders from settling out after being mixed with water.

Emulsifiable concentrates (EC):  This formulation consists of an active ingredient in a liquid organic solvent. An emulsifier is added to allow the concentrate to be mixed with water.  Spreaders and stickers are often included to facilitate better plant coverage.  Emulsifiable concentrates are easy to transport and store, but care should be exercised when working with the concentrated product.  A variety of spraying equipment is available for applying ECs and other liquid formulations.

Flowables (F):  This formulation consists of solid pesticide particles suspended in a liquid.  Their use and application is similar to emulsifiable concentrates.

Ultra low volume (ULV):  ULV formulations consist of the pesticide active ingredient dissolved in an organic solvent.  They are the most concentrated liquid formulations (generally >90% active ingredient). ULV formulations are designed to be used as purchased.  Special sprayers that apply a very small amount per unit area are needed for application.  ULV formulations are generally quite hazardous because of their high concentration of active ingredient.

Fumigants:  Fumigants are pesticides in the gaseous state that are generally used in an enclosed environment (warehouse, grain bins, etc.).  Some fumigants are sold as gases (e. g., methyl bromide), while others are sold as solids that become gas when exposed to the atmosphere (aluminum phosphide). Fumigants tend to be highly toxic and only well-trained persons should be authorized to use them.

# Appendix F

## FAO International Code of Conduct on the Distribution and Use of Pesticide