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9. ABSTRACT

This programmatic Environmental Impact Statement on A.I.D.'s pest management activities includes activities conducted or supported by A.I.D. for the procurement or use of pesticides. Five alternative pest management programs are evaluated for their beneficial and adverse effects on human health, the environment, economics, agriculture, and social organization. One alternative is identified which appears to be the best for both public health and food production. However, there are many component elements to consider in detail in developing specific pest management programs for individual regions, countries, or geographic areas. These alternatives are discussed in detail. Chapter titles include: "Historical Analysis of the AID Pest Management Program;" "Currently Identified AID Pest Management Programs;" "Alternatives for the AID Pest Management Program;" "Environmental Impacts of Alternative AID Pest Management Programs;" "Future Pest Management Program Evaluation;" "AID's Future Pest Management Policies and Strategies;" and "Consultation, Review, and Response."

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Environmental Impact Statement on the AID Pest Management Program

Volume I–Environmental Impact Statement

May 13, 1977

United States Agency for International Development
Department of State
Washington, D.C. 20523

FOREWORD

The Agency for International Development (AID) has prepared this programmatic Environmental Impact Statement (EIS) on its pest management activities with the assistance of Midwest Research Institute (MRI) and RvR Consultants. Included are such activities conducted, supported or otherwise assisted by AID for the procurement or use of pesticides.

The draft of this EIS was distributed to the Department of State, the Council on Environmental Quality (CEQ), the U.S. Environmental Protection Agency (EPA), and other federal agencies with jurisdiction by law or special expertise with respect to the environmental impact involved, members of Congress, and members of the public for their review and comment. In addition, the draft was distributed to concerned international organizations, foreign governments entitled to receive AID assistance, and AID overseas Missions.

A number of substantive comments received from reviewers of the draft EIS have been incorporated into this document. Specific responses to these comments have been included in Chapter VII, as well as other appropriate sections of the final EIS. Copies of all comments received on the draft have been included in an appendix. Copies of this final statement will be sent to all who made comments on the draft.

Any comments concerning the final EIS should be submitted within 45 days to Environmental Coordinator Albert Printz, Agency for International Development, Washington, D.C. 20523.

This EIS consists of two volumes: Volume I - Environmental Impact Statement, and Volume II - Appendices.

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GLOSSARY

AAASA: Association for the Advancement of Agricultural Sciences in Africa.

ADAS: Agricultural Development and Advisory Service, MAFF.

ADI: Allowable Daily Intake.

AI: Active Ingredient.

AID: Agency for International Development (US).

AID/W: Washington, D.C. Offices of AID.

ALRC: Anti-Locust Research Centre (UK).

ARC: Agricultural Research Council (UK).

ARI: Agricultural Research Institute (Cyprus).

ASECNA: Agence pour la Sécurité de la Navigation Aérienne en Afrique et Madagascar.

ASLIB: Association of Special Libraries and Information Bureau (UK).

AVRDC: Asian Vegetable Research and Development Centre (Taiwan).

BCPC: British Crop Protection Council.

BRRI: Building and Road Research Institute (Ghana).

CARIS: Current Agricultural Research Information Service (FAO-Italy).

CATIE: Centro Agronomico deo Investigation y Ensenanza (Costa Rica).

CDC: Center for Disease Control (U.S. Public Health Service).

CENTO: Central Treaty Organization (Iran).

CEQ: Council on Environmental Quality (US).

CGIAR: Consultative Group on International Agricultural Research.

CIAT: International Centre of Tropical Agriculture (Columbia).

CIBC: Commonwealth Institute for Biological Control.

CIDA: Canadian International Development Agency.

CIE: Commonwealth Institute of Entomology.

CIEA: Department of State Committee on International Environmental Affairs (US).

c.i.f.: Cost, Insurance, and Freight.

CIH: Commonwealth Institute of Helminthology.

CIMMYT: Centro Internacional de Mejoramiento de Maiz y Triao (Mexico).

CIP: Commodity Import Program; International Potato Center (Peru).

CMI: Commonwealth Mycological Institute.

CNRS: Centre Nationale Recherche Scientifique (France).

CIPAC: Collaborative International Pesticides Analytical Committee.

CPPTI: Central Plant Protection Training Institute (India).

COM/CPS: Commodity and Procurement Support Division (AID).

COPR: Centre for Overseas Pest Research (UK).

CSIRO: Commonwealth Scientific and Industrial Research Organization (Australia).

CY: Calendar Year.

DLCC: Desert Locust Control Committee (FAO).

DLCOEA: Desert Locust Control Organization for Eastern Africa.

DLIS: Desert Locust Information Section (COPR).

DOE: Department of the Environment (UK).

EAAFRO: East African Agriculture and Forestry Research Organization.

EAC: East African Community.

ECA: Economic Cooperation Administration.

ECRO: European Chemoreception Research Organization.

EIS: Environmental Impact Statement.

ELSE: European Association of Editors of Biological Periodicals.

EPA: Environmental Protection Agency (US).

EPPO: European and Mediterranean Plant Protection Organization.

ERTS: Earth Resources Technology Satellite.

ESC: European Standards Committee.

FAO: Food and Agriculture Organization of the United Nations.

f.a.s.: Free Alongside Ship.

FPRI: Forest Products Research Institute (Ghana).

FPRL: Forest Products Research Laboratory (UK).

FY: Fiscal Year.

GIFAP: Groupement International des Associations Nationales des Fabricants de Pesticides.

GNP: Gross National Production.

IAAC: International Agricultural Aviation Centre (Netherlands).

IAALD: International Association of Agricultural Librarians and Documentalists.

IAC: International Agricultural Centre (Netherlands).

IARC: International Agency for Research on Cancer.

IARI: Indian Agricultural Research Institute.

IBPGR: International Board for Plant Genetic Resources.

IBRD: International Bank for Reconstruction and Development.

IC: Imperial College of Science and Technology, University of London.

ICA: International Cooperation Administration.

ICAITI: Instituto Centro America de Investigacion y Technologia (Guatemala).

ICAR: Indian Council for Agricultural Research.

ICARDA: International Center for Agricultural Research in Dry Areas (Lebanon).

ICIPE: International Centre for Insect Physiology and Ecology (Kenya).

ICRISAT: International Crops Research Institute for the Semi-Arid Tropics (India).

IDRC: International Development Research Centre (Canada).

IITA: International Institute of Tropical Agriculture (Nigeria).

ILCA: International Livestock Centre for Africa.

ILO: International Labor Organization (Geneva).

ILRAD: International Laboratory for Research on Animal Diseases (Kenya).

INTA: National Institute of Agricultural Technology (Argentina).

IOBC: International Organization for Biological Control.

IOBC/WPRS: West Palearctic Regional Section of IOBC.

IRLCOCSA: International Red Locust Control Organization for Central and Southern Africa.

IRRI: International Rice Research Institute (Philippines).

ISO: International Standards Organization.

IUSSI: International Union for the Study of Social Insects.

LDC: Less Developed Country.

LRD: Land Resources Division (ODM).

LSHTM: London School of Hygiene and Tropical Medicine.

MAFF: Ministry of Agriculture, Fisheries and Food (UK).

MAGN: Ministerio de Agricultura y Ganadia de la Nacion (Argentina).

MES: Malaria Eradication Service.

MT: Metric Tons.

NAL: National Agricultural Laboratories (Kenya).

NAS: National Academy of Sciences (US).

NASA: National Aeronautics and Space Administration (US).

NEPA: National Environmental Policy Act of 1969 (US).

NERC: Natural Environment Research Council (UK).

NIH: National Institutes of Health (US).

NIOSH: National Institute for Occupational Safety and Health (US).

NRACC: Natural Resources Advisers Coordinating Committee of ODM.

OCCGE: Organisation de Coordination et de Coopération pour la Lutte contre les Grandes Endémies en Afrique de l'Ouest (Upper Volta).

OCLALAV: Organisation Commune de Lutte Antiacridienne et de Lutte Antiaviare (Senegal).

OCP: Onchocerciasis Control Programme (West Africa).

ODM: Ministry of Overseas Development (UK).

OECD: Organization for Economic Cooperation and Development (France).

OICMA: Organisation International contre le Criquet Migrateur Africain (Mali).

ORSTOM: Office de la Recherche Scientifique et Technique Outre-Mer (France).

OSMC: Overseas Spraying Machinery Centre, Imperial College ( ).

OSRO: Office of Sahelian Relief Operation.

PAAD: Program Assistance Approval Document.

PAHO: Pan American Health Organization.

PAIP: Program Assistance Initial Proposal.

PARD: Program Assistance Review Document.

PICL: Pest Infestation Control Laboratory, MAFF.

PID: Project Identification Document.

PP: Project Paper.

PRP: Project Review Paper.

PIO/C: Project Implementation Order for a Commodity (Pesticide).

PUDOC: Publication and Documentation Centre (Netherlands).

SCI: Society for Chemical Industry (UK).

SIDA: Swedish International Development Authority.

SIE: Secretariat for International Ecology (Sweden).

SIRM: Sterile Insect Release Method.

SNEM: Service National d'Eradication of Malaria (Haiti).

TAB: Bureau for Technical Assistance, AID.

TCA: Technical Cooperation Administration.

TNO: Organisatie voor Toegepast-Naturwitenschapelijk Ondezoek (Netherlands).

TPI: Tropical Products Institute, ODM.

TPRI: Tropical Pesticide Research Institute (Tanzania).

TSPC: Tropical Stored Products Centre, ODM.

UC/AID: University of California - AID.

UN: United Nations.

UNDP: United Nations Development Programme.

UNEP: United Nations Environment Programme.

UNESCO: United Nations Educational, Scientific and Cultural Organization.

UNICEF: United Nations Children's Fund.

USDA: United States Department of Agriculture.

USPHS: United States Public Health Service.

WARDA: West African Rice Development Association (Liberia).

WMO: World Meteorological Organization of the United Nations.

WHO: World Health Organization of the United Nations.

WRO: Weed Research Organization (UK).

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

ENVIRONMENTAL IMPACT STATEMENT ON
THE AID PEST MANAGEMENT PROGRAM

SUMMARY

Prepared in accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969 (PL 91-190).

I. Draft ( ) . Final (X)

II. United States Agency for International Development

III. Name of Action: Administrative (X) Legislative ( )

IV. Brief Description of Action:

A description is given of past, present, and anticipated AID pest management activities in the fields of public health and food production and preservation. These activities include research, training, and technical assistance in the integration of physical, chemical, cultural, biological, and other pest control techniques as well as the procurement and use of pesticides. A description is given of Agency contributions to various international health and agricultural organizations. Historical AID policies, guidelines, and regulations for procurement of pesticides are also reviewed.

Five alternatives are described and evaluated. The environmental impacts of these five alternatives are assessed and compared. Analytical methodologies are developed and used to identify the alternative having the most beneficial and least adverse overall impact on less developed countries.

Specific policies and strategies for implementing the overall AID pest management program are also developed.

V. Summary of Environmental Impact and Adverse Environmental Effects:

An evaluation of five alternative pest management programs is made by considering the beneficial and adverse effects on five major areas of impact: human health, environment, economics, agriculture, and social organization.

The evaluation is made by considering the impacts of the two major AID program areas (public health, and food production and preservation) on the recipient country and on the United States.

In general for recipient countries, as well as for the United States, one alternative appears to have the most positive impact in the five indicator areas for both public health and food production. However, there are many component elements of the five impact areas which must be considered in detail in developing specific pest management programs for individual regions, countries, or geographic areas.

VI. List of Alternatives Considered:

A set of alternatives for the future AID pest management program has been selected based on currently identified pest management activities (through 1978). Major emphasis in selection of the alternatives for analysis was given to variations in activities related to pesticides which is the element of pest management having the greatest potential for environmental impact.

Alternative A represents the implementation of the currently identified AID pest management activities. All research, training, and technical assistance, and other project activities would be accomplished as originally planned. Pesticides procurement or use would be controlled by AID regulations and procurement methods as they existed immediately prior to December 5, 1975. This was the date of a stipulation which was entered into with the plaintiffs in Environmental Defense Fund vs. Agency for International Development, U.S. District Court, D.C. Civil Action No. 75-0500, requiring inter alia that AID prepare a detailed environmental impact statement on its pest management program and adopt new environmental regulations. The AID Environmental Procedures (Regulation 16) which became effective June 30, 1976 would be applied to all pest management activities. Alternative A provides the baseline of activity and environmental impact with which the effects of the other four alternatives can be compared.

Alternative B, which AID has selected, will require that any proposed pesticide activity, i.e., procurement and/or use of pesticides, be evaluated in the context of AID's overall pest management activities in a country or region. This evaluation will take into consideration the regulatory status of the pesticide as established by EPA under the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended and regulations promulgated there under. A risk/benefit analysis appropriate to the pesticide's regulatory status will be performed. When assistance for the pesticide is provided, it will be accompanied by sufficient technical assistance to ensure that the supplied pesticide is used safely and effectively in an environmentally acceptable manner. Regulation 16 would apply and AID will promulgate the additional regulations necessary to implement this policy at an early date.

Alternative C represents continued conduct of pesticide activities under the specific limitations established in the Stipulation of December 5, 1975 and the requirements of Regulation 16. Research, training and technical assistance, and other program activities would remain unchanged from Alternative A.

Alternative D includes the complete elimination of the procurement or use of pesticides in all AID programs. Research, training and technical assistance, and other pest management activities would be unchanged from Alternative A.

Alternative E presents the elimination of all elements of pest management activity from AID's development and security supporting assistance programs. Future fiscal commitments in the area of pest management would be cancelled, and ongoing projects and program activities would be summarily terminated.

VII. List of Federal, Private, and International Organizations and Members of Congress from Whom Comments Have Been Received:

U.S. Federal Organizations
- Department of Agriculture
- Agricultural Research Service, USDA
- Department of Health, Education and Welfare
- Department of the Interior
- Bureau of Oceans and International Environmental and Scientific Affairs, Department of State
- Coast Guard
- Federal Aviation Administration
- Environmental Protection Agency
- Council on Environmental Quality
- Senate Foreign Relations Subcommittee

International Organizations
- Food and Agriculture Organization of the United Nations
- World Health Organization of the United Nations
- International Labor Organization
- United Nations Environmental Programme
- Organization for Economic Cooperation and Development
- United Nations Educational, Scientific, and Cultural Organization

Other U.S. Organizations
- Center for Law and Social Policy
- National Research Council, National Academy of Sciences
- The Institute of Ecology
- Rachel Carson Trust for the Living Environment, Inc.
- Threshold
- Friends of the Earth

Foreign Governments
- Government of Guyana
- Government of Equador
- Government of Kenya

Interested Individuals
- Sumitomo Chemical America, Inc.

VIII. The draft statement was made available to the Council on Environmental Quality and the public on September 30, 1976. The final statement was sent to the Council on Environmental Quality and made available to the public on May 13, 1977.

INTRODUCTION

This document is a programmatic Environmental Impact Statement (EIS) on the activities conducted, financed, supported, or otherwise assisted by the Agency for International Development (AID) which are intended to control or eliminate pests, including the procurement or use of pesticides. These activities, for purposes of this EIS, have been collectively termed the AID Pest Management Program.

This EIS partially fulfills the commitment made by the Agency in 40 Federal Register 57696 (December 11, 1975), as well as the specific requirements of the Stipulation and Court Order, Civil Action No. 75-0500, U.S. District Court for the District of Columbia, December 5, 1975.

The Agency for International Development has supported and wherever possible has taken the initiative on the promotion of safe, effective use of pesticides in integrated pest management programs. AID has recognized that the proper selection and use of pesticides contribute to increased agricultural productivity and improved public health. Integrated pest management schemes reduce the harmful environmental effects caused by the sole and improper use of pesticides to eliminate unwanted pests.

While AID and the U.S. Government are responsible for programs they support in pest management, it must be recognized that the decisions regarding development policies and practices in the less developed countries (LDC's) lie with the sovereign governments of those nations. United States influence in these decisions varies from case to case, but in all instances must be exercised in a collaborative and sensitive style if we are to continue to be a welcomed force in development assistance.

CHARACTERIZATION OF THE AID PEST MANAGEMENT PROGRAM

AID anticipates continued efforts addressed to the basic areas of food and nutrition, population and health, education, and human resources development. The overall AID assistance program will include development assistance through loan and grant programs of technical assistance, research and training, and commodity support. Specific pest management activities have been identified through calendar year (CY) 1978. Nations for which any type of AID assistance has been proposed for fiscal year (FY) 1977 are shown in Figure 1.

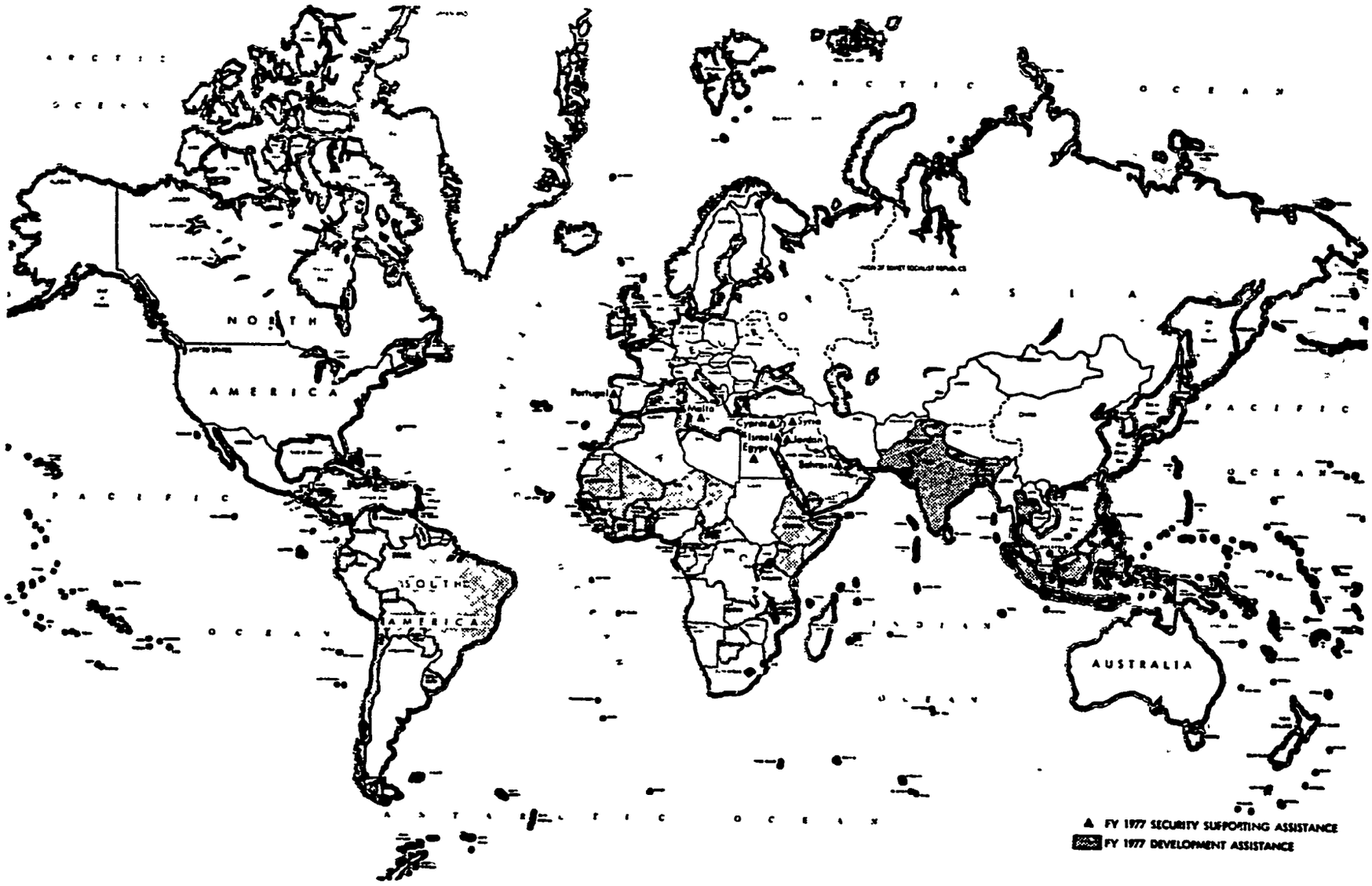

Figure 1 - Proposed AID Assistance for Fiscal Year 1977

Many of these diverse development assistance activities include elements of pest management. A few proposed activities deal exclusively with pest management.

The AID pest management program can be categorized according to (a) the purpose or intent of the various activities (program areas); (b) the types of pest management activities (program elements); and (c) the sites of the pest management activities or those of their potential impacts (geographical regions). The program areas, program elements, and geographical regions are as follows:

Program Areas

Food production and preservation
Public health
All other pest management programs

Program Elements

Pesticide activities
Research
Training and technical assistance
Other pest management activities*

Geographical Regions

United States
Less developed countries
Extraterritorial global areas

This categorization of the potential AID pest management program is depicted in Figure 2. All 36 cubes depict potential areas of activity or potential impact. The shaded cube in the upper right of the figure, for example, represents the conduct (or impact) of research on food production and preservation in the United States.

DEFINITIONS

Five key terms are used in this section and throughout the EIS document. The applicable definitions for these terms are as follows:

---

* "Other Pest Management Activities" include those pest management projects in less developed countries that do not involve the use of pesticides. Examples would be land clearing or the draining of swamps in order to control vectors of human disease, or assistance in the building or improvement of LDC infrastructures for pest or pesticide management.

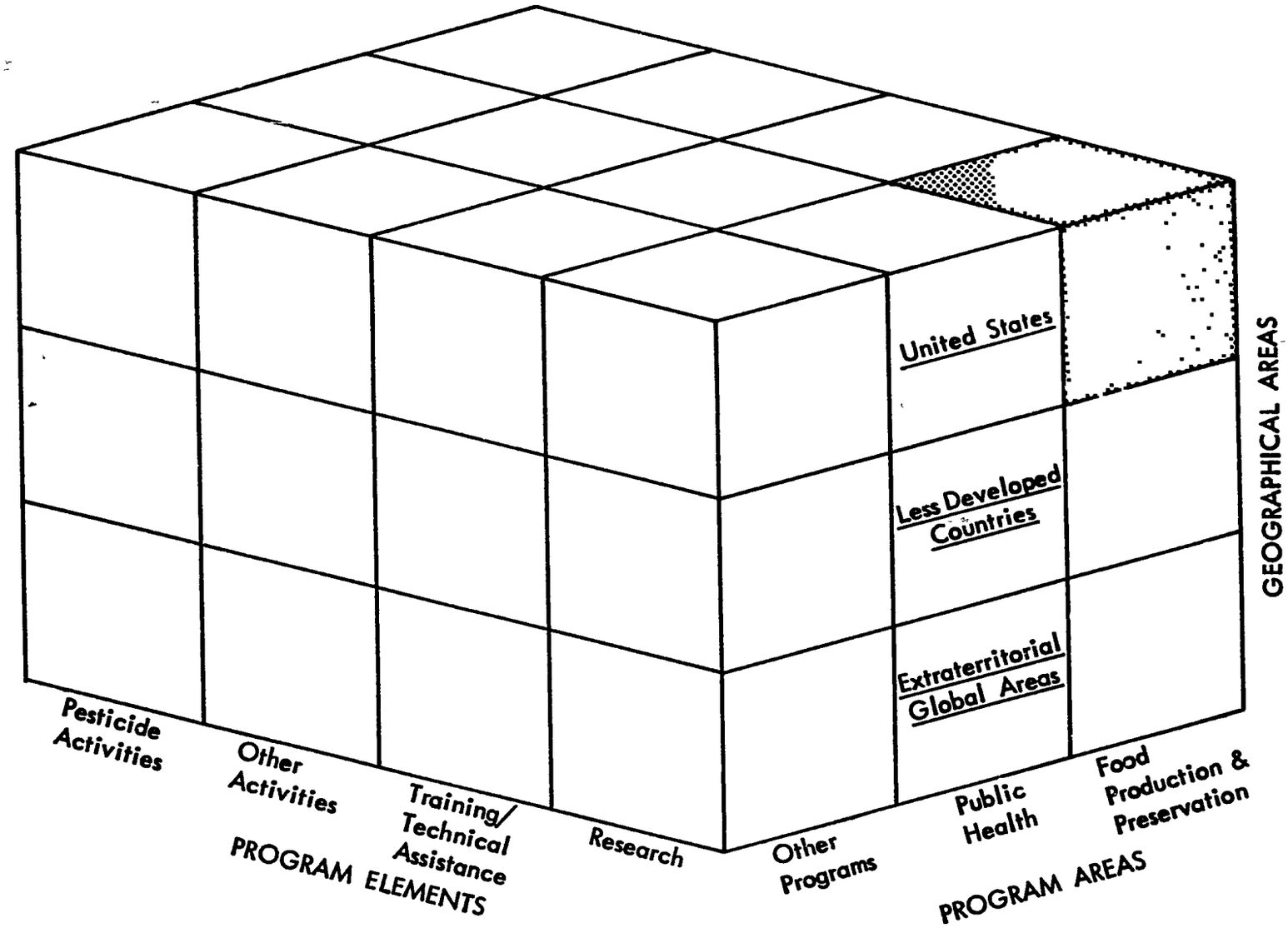

Figure 2 - Characterization of the AID Pest Management Program

Pests - unwanted insects, mites, rodents, nematodes, fungi, bacteria, viruses, weeds, and other forms of plant or animal life causing injury, disease or destruction to desirable plants, animals, structures, goods, or to man himself.

Pesticides - substances or mixtures of substances, intended for preventing, destroying, repelling, or mitigating any unwanted insects, rodents, nematodes, fungi, weeds, and other forms of plant or animal life or viruses, bacteria or other microorganisms (except viruses, bacteria or other microorganisms on or living in man or other living animals); or intended for use as plant regulators, defoliants, or desiccants.

Pesticide activities - all activities conducted, supported, financed, or otherwise assisted by AID for the procurement or use of pesticides, but do not include pesticide research and pesticide regulatory activities.

Pest management program - all activities conducted, supported, financed, or otherwise assisted by AID intended to control or eliminate pests.

Integrated pest management (IPM) - IPM has been defined as the system of pest management that will bring the most benefits, at the most reasonable costs, on a long-term basis, to the farmer and to society. An IPM program attempts to combine control practices with the existing components of the environment to bring about the most effective, least ecologically disruptive pest control possible. Thus, an IPM program relies in part upon natural controls and biological methods, but utilizes chemical technologies as needed to suppress pest populations to an economically acceptable level, and to handle heavy infestations and public health hazards.

REPORT ORGANIZATION

This Environmental Impact Statement has been organized as two volumes:

Volume I (this volume of the EIS) is the main body of the report. This volume contains seven chapters that address the general subject areas required for an Environmental Impact Statement and required by the stipulation of December 5, 1975:

Historical Analysis of the AID Pest Management Program,

The Currently Identified AID Pest Management Program (Through CY 1978),

Alternatives for the AID Pest Management Program,

Environmental Impacts of Alternative AID Pest Management Programs,

Future Pest Management Program Evaluation,

Future Pest Management Policies and Strategies, and

Consultation, Review, and Response.

A glossary of terms has been included at the front of Volume I.

Volume II contains eight appendices:

Appendix A - National Academy of Sciences Committees (the committees who studied the environmental aspects of AID's programs in January 1970).

Appendix B - Current and Historical Pesticide Data (information on the specific pesticides that AID has financed in the past and may finance in future pest management activities).

Appendix C - Agency for International Development, Regulation 16 - Environmental Procedures.

Appendix D - Interim Regulations on Provision of Assistance for Procurement and Use of Pesticides.

Appendix E - Stipulation and Court Order, Civil Action No. 75-0500, U.S. District Federal Court for the District of Columbia, December 5, 1975.

Appendix F - Audit Report, Malaria Eradication Programs (AID audit report on its malaria program for the period January 1, 1973 to December 31, 1975).

Appendix G - University of California/Agency for International Development Pest Management and Related Environmental Protection Project, 1974 to 1975 Annual Progress Report.

Appendix H - Letters of Comments Received on the Draft Environmental Impact Statement.

References have been listed at the end of each section or chapter of the EIS document.

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CHAPTER I

HISTORICAL ANALYSIS OF THE AID PEST MANAGEMENT PROGRAM

This chapter presents a historical description of AID's pest management program, generally for FY 1970 through FY 1975, except for a few instances (noted in the text) in which activities are described in other time frames in order to preserve continuity and avoid redundancy. Current AID pest management activities and those projected activities that can currently be identified (through CY 1978) are discussed in Chapter II.

ORIGIN AND PURPOSE

The mission of the U.S. Agency for International Development and its predecessor foreign aid agencies has been to help upgrade the quality of life of the poor in less developed countries, and to provide economic and technical assistance to such countries. Basic needs in developing countries have included adequate supplies of food and protection of human health (1).

Production of foods and fiber and protection of human health in less developed countries are often impaired by pests. In these countries, such pests cause staggering pre- and postharvest crop losses. A number of pests are vectors of parasitic diseases including malaria, sleeping sickness (trypanosomiasis), river blindness (onchocerciasis), schistosomiasis (bilharzia), filariasis, and others.

For many years, assistance to less developed countries provided by AID and its predecessor organizations under authority of the Foreign Assistance Act of 1961 (2) as amended has included pest management assistance, i.e., pest control technology and chemical pesticides.

AID has provided pesticides and other forms of pest management assistance through multilateral or bilateral agreements. Multilateral programs were often planned, executed, and administered by international agencies including the World Health Organization (WHO), the Food and Agriculture Organization (FAO), or other agencies of the United Nations, or through regional organizations such as the Pan American Health Organization (PAHO). Bilateral assistance was provided through agreements with individual less developed countries.

Regardless of the contractual form, AID pest management assistance to less developed countries has been provided for the following three basic purposes:

1. Human health protection, primarily control of insect vectors of malaria and other vector-transmitted diseases.

2. Food crop protection, i.e., management or control of pests reducing crop yields or causing postharvest losses.

3. Livestock protection, primarily control of insect pests harmful to livestock.

Pursuit of these goals in AID programs has been subject to three important principles, i.e., protection of public health and safety; preservation of environmental quality; and avoidance of adverse impacts on neighboring nations.

HISTORICAL POLICIES, GUIDELINES, AND REGULATIONS

AID's pesticide and pest management activities have been, first of all, subject to all applicable AID general policies, rules, and regulations, and operate within the statutory authorities provided by the Foreign Assistance Act of 1961, its amendments, and the annual Foreign Assistance and Related Programs Appropriation Bills. Policies, guidelines, and regulations that pertained more specifically to AID's pesticide and pest management activities as they existed prior to 1976 are as follows:

AID Environmental Assessment Guidelines

The AID Environmental Assessment Guidelines Manual was issued in September 1974 to delineate AID's total environmental concern, and to spell out in greater detail AID procedures for consideration of environmental aspects of AID capital projects which were issued in 1970 and 1971 (3). The Manual states:

> "It is the policy of AID to conform with the spirit, intent and objectives of the National Environmental Policy Act of 1969 (NEPA, Public Law 91-190) with respect to all development activities abroad which are financially assisted with U.S. Government funds.
>
> "The spirit, intent and objectives of the NEPA are that the U.S. will 'promote efforts which will prevent damage to the environment and biosphere, and stimulate the health and welfare of man.'"

The Manual sets forth procedures for consideration of environmental factors of development projects and other forms of assistance, and general and specific guidelines for making detailed assessments of the environmental effects of proposed development projects.

In Appendices, the Manual includes:

* The full text of the National Environmental Policy Act of 1969 (Public Law 91-190).

* Detailed procedures and instructions for incorporating environmental assessments into AID-financed projects.

* Selected bibliographies of environmental publications, subdivided into general interest, agriculture, industry, transportation, utilities, standards, and public health.

* A listing of international institutional resources.

In the discussion of potential environmental impacts to be evaluated, the Manual refers to pests, pesticides, and related problems specifically in the sections on agricultural development, irrigation, and public health projects. The following factors are listed as requiring consideration.

Agricultural development (including range management)

* Impact of introduced agricultural technologies such as pesticides.

* Introduction of new plant diseases, insects, or rodents.

* Agrobusiness expected to be generated.

* Potential for pollution of domestic water supplies by increased or new use of pesticides.

Irrigation systems

* Pesticide contamination of surface and ground waters due to irrigation water or rainfall runoff.

* New diseases and vector patterns which may be introduced or aggravated by new or expanded water-related ecosystem.

* Pesticide storage or use which may require new safety precautions.

Pesticide use in public health projects

* Malaria or other disease vector control projects are listed among projects clearly requiring environmental impact analysis because of potential deleterious environmental side effects such as air or water pollution and effects on ecological systems.

National Academy of Sciences Recommendations and Their Implementation

In the early 1960's it was AID's policy that a sovereign state eligible for United States foreign assistance should retain its right to purchase, with AID funds, any pesticide it desired, and to dictate how the product should be used within its own borders (4). This policy assumed that receiving countries would be willing and able to assume full responsibility for protection of their citizens, their resources, and their national interests. However, it did not accommodate the fact that pests and pesticide problems may transcend national borders.

During the mid-1960's, concern for environmental quality emerged strongly in the United States and in many other countries. The effects of indiscriminate use of chemical pesticides received special attention. In 1969, sensitive to these developments, AID requested the National Academy of Sciences (NAS) to review certain aspects of the United States foreign assistance programs in regard to their possible environmental effects. In January 1970, two NAS Committees studied AID's pesticide and pest control programs and made the following general and specific recommendations regarding future AID pest management activities. (The membership of both committees is listed in Appendix A.) The general and specific recommendations for both agriculture and public health are numbered consecutively below. Activities undertaken by AID to implement these recommendations are subsequently discussed.

Agriculture

General recommendations

1. Appointment of a permanent pesticides and pest control advisory committee composed of scientists and specialists from federal and state agencies, universities, foundations, institutions, and industry, to consider pest control problems in the developing countries, evaluate information on the hazards of pesticides to human health and environmental quality, and to advise AID on pesticide usage and pest control activities in its foreign assistance programs.

2. Increased AID participation in international cooperative efforts to promote safe and effective usage of pesticides and to develop and promote programs of ecological, biological, and integrated pest control.

3. Increased AID support of research, education, and training in all methods of pest control, the effects of pesticides on human health and on the ecosystems, and on improved techniques for prediction and detection of potential side effects from pesticide usage.

4. Review pesticide selection, procurement, and use in AID public health and agricultural pest control activities to assure effective pest control while minimizing human and environmental exposure to pesticides that may constitute a hazard to human health or to desirable elements of the environment.

Specific recommendations

5. Determine the sources of information on pest control within the developing country.

6. Conduct aggressive recruiting and training programs to permit the establishment of adequately trained personnel, together with suitable modern equipment, supplies, and facilities in the developing country, or in a centralized location for several small countries with similar or identical problems, for the development of proper pest control research, education, practical training, and extension.

7. Require that all requests for pesticides procurement be fully documented to permit a more thorough evaluation of the pest situation, the need for the specific pesticide requested, methods of application to be utilized, and potential hazards to man, his domestic animals, wildlife, and impact on the overall environment.

8. Require and arrange for expert posttreatment evaluations of major pest control operations to determine efficacy of methods and chemicals under local conditions and impact of chemicals on man and his environment.

9. Require that all major and/or long-term pesticides procurement and usage programs financed by AID for the developing country be firmly tied to acceptance by the recipient country of joint AID-host country programs of research, education, training, and institution building in pest control and related problem areas in order to raise the level of professional and subprofessional knowledge and expertise on a self-sustaining basis within the host country.

10. Review and consider current and projected staff and budget needs of the Office of Agriculture and Fisheries, Bureau for Technical Assistance, in the light of Agency and worldwide problems and needs, and the swift pace of developments in these highly technical and critical areas. Essential activities need to be improved or initiated by administrative and fiscal action.

11. Must be concerned with the administrative review and approval of "tenders" submitted by the developing countries for agricultural pesticides; however, over-concern for this aspect of the pesticides-pest control problem can lead only to bureaucratic morass. In the long run, the Agency should be concerned with its larger role and activities in pest control matters.

Public Health

General recommendations

12. Endorsement of the recommendations of the Department of Health, Education, and Welfare Secretary's Commission on Pesticides and Their Relationship to Environmental Health ("Mrak Report") (5), and those of the World Health Assembly in respect to the use of pesticides in health improvement programs supported by AID, especially antimalaria programs. The Panel emphasized the critically important role of DDT in worldwide antimalaria programs, its good performance and safety record in such programs, the lack of feasible DDT replacements, and the need for increased research for new alternative insecticides or other methods of vector control.

Specific recommendations

13. Continue the use of DDT or other persistent pesticides in combating disease vectors, e.g., the mosquito vectors of malaria, where withdrawal of such uses would result in increased incidence of illness and mortality to a degree which would clearly exceed the potential detrimental effect of pesticides on human health and the environment.

14. Vigorous support by AID of research efforts, both in-house as well as by other federal and international agencies, in the following areas:

a. Development of new approaches to vector control which minimize use of pesticidal chemicals, utilize chemicals which have little or no potential for hazards to humans or degradation of the environment, or depend on biological-ecological methods.

b. Investigations of the extent of contamination of human populations and the environment under conditions of current use of pesticides, particularly DDT, in malaria and other vector-borne disease control programs.

Activities were initiated by AID to implement most of the National Academy of Sciences recommendations. Perhaps the most far-reaching of these endeavors was the work initiated with the University of California. AID concluded an agreement with the University of California in 1971 under which the University has assisted AID in immediate problems as well as in the development of a long-range pest management strategy for continued AID assistance to less developed countries.

In carrying out the contract objectives, the University of California has become the lead institution in a university consortium including the University of Florida, Cornell University, North Carolina State University, Oregon State University, and the University of Miami (6). Since its inception, this contract has provided AID with highly competent advice and support

in all matters related to agricultural pesticide use and pest management in less developed countries.

In the area of pesticide management, contract tasks were carried out initially by a Panel on Pesticides which held its organizational meeting in September 1971 and thereafter met on an ad hoc basis between four and six times annually. Subsequently, this Panel was reconstituted as a part of the AID Pest Management Advisory Group.

Through this Panel and later through the Advisory Group, pesticide scientists and other experts reviewed AID pesticide procurement procedures and pesticide product and packaging descriptions and developed criteria for the identification of especially hazardous products.

The activities conducted under this contract are described in detail on pages 64 through 73, and in Appendix G. In addition, other projects and programs were initiated as funds became available (and are continuing to be conducted) that were responsive to the recommendations of the Academy, as described on pages 73 through 83.

AID's Historical Pesticide Procurement Policies and Procedures

1960's to 1971--

During the 1960's AID designated all pesticides as commodities requiring individual, case-by-case prior approval by AID/Washington (AID/W). Under these "prior approval" procedures, prospective receiving countries and AID missions had to submit pesticide specifications and use justifications to AID/W. The Industrial Resources Division of the Office of Procurement, AID/W, determined that the pesticides requested were commercially identifiable and legitimate United States formulations. The Agricultural Division of the Technical Assistance Bureau made the technical examination of each case, and a decision was then made whether or not AID could finance the transaction. This process of individual evaluation of each and every transaction was quite time-consuming.

1971 through 1975--

In 1971, AID developed a "positive list" of commodities, including pesticides, eligible for AID financing. This list was first developed for the Commodity Import Program (CIP) for Vietnam. It was subsequently adapted to worldwide use. The commodity and packaging specifications for pesticides which had been found acceptable for Vietnam were used, and specifications for additional acceptable pesticide products were continually added. This list was then published as a part of the "AID Commodity Eligibility Listing," as a "Small Business Memo" or "Trade Memo." This pesticide listing was updated from time to time and was included in AID Handbook 15 (7). The last revision of the pesticide section of this Handbook (Section II, pages 69 through 112) is dated December 16, 1974. It was in effect until January 1976, when it was superseded by the "interim regulations on provisions of assistance for procurement and use of pesticides" (see page 108).

AID's policies and regulations governing procurement of pesticides for developing countries, applicable prior to 1976, are set forth in AID Handbook 15 as follows.

a. Pesticides are biologically active substances which are toxic to one or more forms of life. They require greater care in handling and use than most other commodities. For these reasons, AID works closely with the U.S. Environmental Protection Agency and the pesticide industry in developing its policies concerning pesticides which are appropriate for AID financing. While careful consideration is given to the diverse needs of recipient countries, and every effort is made to provide a sufficiently wide range of eligible pesticides to cope with most problems, AID is obliged to review the proposed utilization and application of certain pesticides in the recipient country prior to authorizing their procurement under AID financing. Within this context, AID has established herein those categories of pesticides which are (a) eligible for AID financing without referral to AID/W for review, and (b) those pesticides of a more toxic or more environmentally degrading nature, which are conditionally eligible subject to the prior review and approval by AID/W.

b. Pesticides which conform to the product and packing specifications shown in this listing, and which are not identified by an asterisk (*) are considered to be "AID-approved."

c. Conditionally Eligible Pesticides are those identified in this list by an asterisk (*). These items require special handling and use precautions for purposes of safety, limitation of environmental damage, and effectiveness. Accordingly, prior to the placing of contracts or orders, for any pesticide identified by an asterisk (*) a detailed certification from a qualified host government official must be submitted to the Director of the AID Mission or AID representative in that country. AID will transmit this certification to its Commodity and Procurement Support Division (COM/CPS), AID/W for review and approval of the specifically proposed purchase. AID/W reserves the right to disapprove AID financing of any Conditionally Eligible Pesticide when in its judgment the proposed use or application of the material poses serious toxicological and/or environmental hazards.

The certification required in detail from the host government is as follows:

HOST GOVERNMENT CERTIFICATION

(1) No suitable less toxic or less environmentally degrading substitute is available for the same application.

(2) If material will be formulated in the recipient country, include the exact formulation to be prepared (i.e., 40% Emulsifiable Concentrate, 10% Granular, or other) and certify that proper equipment and technically trained personnel are available for such formulation.

(3) The imported product or formulation outlined above will be safely applied and will be limited to the following:

Crop	Method of Application	Proposed Amount (kg/hectare)
A. _____	_____	_____
B. _____	_____	_____
C. _____	_____	_____
D. _____	_____	_____

_____

Signature and Title of Host Government Official - Date

d. Proposed procurements of pesticides not included in this AID listing may be approved on a case-by-case basis. Host government and/or importers should provide all pertinent details relating to the specific pesticide desired in order to expedite review by AID/W. Detailed information of each product should be obtained from the producer and must include product and packing specifications, history of use, effectiveness of material, toxicity, and potential environmental hazards. Producers may also approach AID/W directly for review of those products under active consideration by cooperating countries for AID financing. Cooperating country requests for eligibility of more toxic and environmentally degrading pesticides must be accompanied by Host Government Certification in the format outlined above.

The pesticide section of the AID Commodity Eligibility Listing dated December 16, 1974, included 92 different pesticide active ingredients (7). Many of these were available as technical and/or in one or more different formulations. The list also included several formulations containing multiple active ingredients (see Table B-1, Appendix B).

The technical and formulated pesticide products included in the list were available in a total of 272 different packages and unit sizes:

Unit Size (kg)	Technical Pesticides	Formulated Pesticides	Totals
Over 100	47	54	101
50-99.9	14	18	32
25-49.9	16	38	54
10-24.9	13	70	83
Under 10	0	2	2

For each of the technical or formulated pesticide products covered, the listing provides product name, chemical name of the active ingredient, type of formulation, active ingredient content, Schedule B number (U.S. Bureau of the Census, Foreign Trade Reports), package size, and a description of the container in which the product was available.

There were no provisions or requirements regarding labeling, directions for use, or safety precautions for conditions prevailing in developing countries, and there was no requirement for labels and use directions to be supplied in the language of recipient countries.

Unlike the pesticide specifications developed by FAO (8) for use in international trade, the product descriptions in the AID list did not cover permitted tolerances for active ingredient (AI) content, acidity, alkalinity, insolubles, water content, or other critical impurities. They did not specify storage stability requirements for the pesticide, nor stability or performance requirements for containers. Physical properties critical to the performance of dry or liquid products such as particle size and range, suspendability, wettability, foaming, dustiness, emulsion stability, reemulsification and miscibility were not specified, and special safety considerations such as explosive hazards were not mentioned. No references were made to the FAO specifications for those pesticides for which they are available, nor to appropriate analytical methods for quality control purposes.

Of the 92 pesticide active ingredients included in the old AID list, 66 were considered to be "AID-approved" in accordance with Subparagraph(b) of the pesticide procurement policy, while 26 were identified by an asterisk (*) as "conditionally eligible pesticides" as defined in Subparagraph(c), requiring special handling and use precautions, detailed certification from the host government, and review and approval of the intended purchase by AID/W.

These procedures subjected all doubtful cases to the same individual scrutiny which formerly was required for all transactions, while orders for "AID-approved" pesticides could be handled with greater dispatch. This system had been in effect since its inception in 1971 up to January 1976 when AID's "Interim Pesticide Regulations" became effective (see page 108).

The historical AID pesticide procurement policies and procedures did not include provision for pre- or post-use audits in recipient countries.

Administrative Procedures--

AID assistance in financing pesticides was also given as "non-project assistance" under the General Commodity Import Program, under AID-financed projects, or in other forms. A brief description of the respective administrative procedures follows.

General commodity import program--Under this program, funds were made available by AID as loans or grants to eligible countries, to support the foreign exhange costs of a broad spectrum of eligible commodities including pesticides (all listed in the "AID Commodity Eligibility Listing"). A proposed transaction was usually initiated by a commercial importer in the receiving country licensed by his government who obtains quotations from pesticide suppliers, an import license, and a letter of credit through his local bank. The prospective supplier submitted the required documents to AID/W for review and approval (Form AID-11). AID determined if the proposed transaction is eligible for AID financing, considering price, terms, and conditions of the supply contract, and compliance with the provisions for pesticides as set forth in the AID Commodity Eligibility List. If and when all conditions were met, the pesticide was purchased and shipped through commercial channels.

Project assistance (AID-financed agricultural and public health projects)--Pesticides were often one element of technical assistance projects, and, in this case, were requested by the recipient government one or more years prior to initiation of the procurement process. Actual procurement was effected directly by the recipient government or, at the request of that government, AID assisted in the procurement by processing a Project Implementation Order for the pesticide (PIO/C). The actual procurement was often assigned to an authorized agent such as the General Services Administration or a private contractor.

Other pesticide procurements--AID also financed local procurement of pesticides (local shelf items) or provided emergency assistance. Such procurements were handled on a case-by-case basis, depending upon the specific circumstances involved.

Notification to Foreign Governments and International Organizations of U.S. Regulatory Actions on Pesticides

Section 17(b) of the Federal Insecticide, Fungicide, and Rodenticide Act as amended (86 Stat. 973-999), entitled "Cancellation Notices Furnished to Foreign Governments," mandates:

> "Whenever a registration, or a cancellation or suspension of the registration of a pesticide becomes effective, or ceases to be effective, the Administrator (of EPA, the U.S. Environmental Protection Agency) shall transmit through the State Department notification thereof to the governments of other countries and to appropriate international agencies."

In accordance with the intent of Section 17(b), EPA developed the following criteria for determining which registration, suspension, and cancellation actions will be transmitted to the governments of other countries and to international agencies.

Registration--

Actions requiring Federal Register publication according to Section 3(c)(4) of the Federal Insecticide, Fungicide and Rodenticide Act as amended, i.e., a "notice of each application for registration of any pesticide if it contains any new active ingredient or if it would entail a changed use pattern."

Cancellation or Suspensions--

Actions which have become effective and have national or international significance as determined on a case-by-case basis. Cancellation or suspension actions are considered to have national or international significance when:

* The action is the result of a review of the basic pesticide.

* The action is the result of findings by others (and adopted by EPA) which indicate a risk applicable to a basic pesticide or class of pesticides.

* The action is the result of safety determinations which require the tolerances for a particular pesticide to be reduced, revoked, or set at zero.

* The action involves issuance of new policy applicable to the entire pesticide industry.

* The action may have, in the opinion of the Administrator (of EPA), widespread environmental, economic, or political implications.

By unclassified message the Department of State transmitted to all United States diplomatic posts, AID missions and offices an explanation of this policy, and 10 notices "pertaining to such actions as described above which have been taken since the creation of the EPA in 1970" (9). Of these 10 notices, nine pertain to suspension or cancellation actions and one to the reinstatement of the registration of a pesticide.

The State Department message states that in the future, notifications to foreign governments and international organizations will be given at the time that United States regulatory actions on pesticides subject to the notification policy take place.

AID PESTICIDE ACTIVITIES

World Use of Pesticides

There are no official, complete statistics on worldwide pesticide production and use. The FAO in its annual Production Yearbook publishes data on pesticides "used in, or sold to, agriculture" in a number of countries. In compiling these data, which are very incomplete, FAO relies on voluntary reports from United Nations member countries. Up to the present (1974 Production Yearbook), cooperation has been less than 50% (10). Some countries report their pesticide uses in terms of active ingredients, others in terms of formulation weights. For these reasons, world totals cannot be calculated or derived from these FAO pesticide data.

In September 1974, responding to a request from the 63rd Session of the FAO Council (July 1974), FAO initiated an information system on pesticide supply and demand. In consultation with the WHO, a question form was developed and sent to 99 governments of less developed countries. The form contained 15 pages of tabulated questions seeking information on past pesticide usage for 1971 through 1973, and future estimated pesticide usage for 1975 through 1977, broken down by herbicides, insecticides, and fungicides, broad chemical groupings, and by-products manufactured or formulated locally and imported. Data on estimated values of these pesticides and on the availability of pesticide application equipment were also requested.

More than 40 countries were unable to provide any of the information sought. Fifty countries returned question forms that had been completed as

far as available data would allow. Of these, 38 countries provided data sufficiently complete for tabulating. India was by far the largest pesticide user in this group, followed by Mexico and Argentina. These three countries combined accounted for 50% of the total pesticide usage of the 38 reporting countries in 1973, and considerably more than 50% of the projected demand in 1977. Several of the largest pesticide users among the developing countries, including Brazil, Egypt, and Pakistan, did not contribute data to the survey. The FAO report on the survey points out that the results are not representative of all developing countries but are influenced heavily by the pesticide use patterns of the three largest reporting countries, especially India (11). The report emphasizes the need for more complete, worldwide information on pesticide demand, supply, and distribution.

Nine of the 38 countries covered in the FAO report received AID-financed pesticides during the period 1971 to 1973, permitting comparisons of their total pesticide use to AID-financed imports from the United States for herbicides, insecticides, and fungicides. (These country-by-country comparisons are presented in Tables 6 to 14, pages 38 to 46.)

The Environmental Studies Board of the National Research Council, National Academy of Sciences, reported that more than 450 million kilograms (1 billion pounds) of pesticide chemicals, worth some $3.4 billion, were used in the world in 1971 (12). The report does not specify whether the quantity given refers to active ingredients or formulated products, nor does it indicate whether the value refers to manufacturers' wholesale or retail price levels.

In 1973, Farm Chemicals published a world pesticide market survey conducted by its staff (13). In this article, the world market for agricultural pesticides was estimated at $2.5 billion at the consumer price level, exclusive of industrial, commercial, home, garden, lawn, and turf pesticides. The survey did not include the USSR, the People's Republic of China, and other centrally planned economies.

Wood, Mackenzie and Company, a firm of stockbrokers in Edinburgh, Scotland, estimated the world agrochemical market at $4,080 million in 1974 (14). Its report covers herbicides, insecticides, fungicides, and plant growth regulators, and estimates that at least 80% of the current sales of pesticides are made in the developed countries.

More recent data and estimates from United Nations and FAO sources and from RvR Consultants indicate that the Wood, Mackenzie and Company estimates for 1974 may be on the low side, even though they probably refer to manufacturers' price levels. The best available current estimate suggests that in 1974, world pesticide use amounted to about U.S. $7 billion (basis consumer prices, including agricultural and all other pesticide

uses). Table 1 presents a breakdown of this total by world economic regions, compared to total land area and cropland area in each region.

The table shows that the developing market economies in Latin America, Africa, and Asia account for nearly one-half of the world's total land area, and for 45% of the world's total cropland area. In all three economic regions, total cropland area (all arable land and land under permanent crops, not including permanent meadows and pastures) is between 10 and 12% of the total land area.

In 1974, the developed market economies (North America, Western Europe, Israel, Japan, South Africa, Australia, and Oceania) accounted for an estimated 77% of the total world pesticide market while they contain only 27% of the world's cropland area. Thus, total pesticide use in the developed market economies was equivalent to $1.65/ha of total land area, and $13.62/ha of total cropland area. The developing market economies used an estimated 10% of all pesticides, equivalent to pesticide expenses of $0.11/ha of total land area, or $1.05/ha of total cropland area.

The centrally planned economies (Eastern Europe, USSR, People's Republic of China and other centrally planned economies in Asia) contain 28% of the world's cropland area and accounted for an estimated 13% of world pesticide consumption in 1974, equivalent to pesticide inputs of $0.26/ha of total land area, and $2.19/ha of total cropland area. Thus, pesticide inputs per unit of land area in the centrally planned economies were more than twice as high as in the developing market economies, but only about one-sixth as high as in the developed market economies.

The FAO pesticide use survey includes data on the past (1971 to 1973) and anticipated future (1975 to 1977) growth rates in pesticide demand in developing countries (11). For the 38 countries reporting, the compounded annual rates of growth for the three main categories of agricultural pesticides were as follows:

	1971-1973 (%)	1975-1977 (%)
Herbicides	32	25
Insecticides	21	9
Fungicides	25	5
Total	23	9

Table 1: Estimated World Use of Pesticides in 1974 by Value[a/], Economic Regions, Total Land Area, and Cropland Area[b/]

Region	Total Land Area 1,000 ha	Cropland Area			Pesticide Use			
			Relative to				On Total Land Area	On Crop-land
		1,000 ha	Land Area %	World %	$1,000	%	$/ha	$/ha
Developed Market Economies (North America, Western Europe, Israel, Japan, South Africa, Australia and Oceania)	3,282,142	396,589	12.1	26.9	5,400,000	77.1	1.65	13.62
Developing Market Economies (Latin America, Africa, Asia, except centrally planned economies)	6,630,918	666,214	10.1	45.2	700,000	10.0	0.11	1.05
Centrally Planned Economies (Eastern Europe, USSR, People's Republic of China and other centrally planned economies in Asia)	3,486,253	410,117	11.8	27.9	900,000	12.9	0.26	2.19
World	13,399,313	1,472,929	11.0	100.0	7,000,000	100.0	0.52	4.75

a/ Basis consumer prices in United States dollars, including agricultural and all other pesticide uses.
b/ Cropland area defined as arable land and land under permanent crops, not including permanent meadows and pastures.
Sources: FAO Production Yearbook (10), RvR Consultants estimates.

For all three pesticide categories, the reporting countries projected considerably lower rates of increase for the future than those experienced between 1971 and 1973. Of the total reported pesticide consumption for 1973, 161,500 MT, herbicides accounted for 10% (16,300 MT), insecticides 66% (106,400 MT), and fungicides 24% (38,800 MT). It is obvious that in developing countries, herbicides do not yet play the major part in agricultural production that they do in countries with an advanced form of agriculture.

Furtick and Smith report that in developing countries, nearly all agricultural pesticides are used on cash crops, and that cotton represents at least half of all use (15). Plantation crops such as sugarcane and tree crops are major consumers of pesticides with vegetables, rice, and corn when they are raised as cash crops of lesser but increasing importance. In some less developed countries, use of insecticides to protect stored products is also of importance.

AID-Financed and United States Shares of Pesticides Used in Less Developed Countries

Methods for Comparisons--

The U.S. Department of Commerce, Bureau of the Census reports exports of pesticides from the United States based on shippers' export declarations which are required to be filed with the U.S. Customs at the time when, and at the port where, an export shipment leaves the country (18). Values of export shipments are reported as the free alongside ship (f.a.s.) value at the port of exportation. This is the cost or selling price of the pesticide plus inland freight, insurance, and other charges to the border. Volume and value of export shipments are reported monthly and summarized by calendar years.

Records on AID-financed pesticide exports are kept by federal fiscal years (FY) which up to 1976 ran from July 1 of the preceding year to June 30 of the year indicated. For fiscal years prior to 1973, information on AID-financed pesticide exports are available by the Bureau of the Census classifications (Schedule B Codes), not by individual products or active ingredients (except for DDT), and only by dollar values, not by quantities (4). Expenditures are recorded by AID at the time that invoices are paid, which usually is some time, often months, after a given shipment actually leaves the country.

Thus, Department of Commerce pesticide export statistics for a given calendar year could include at the most only one-half of the AID-financed pesticide exports as recorded by AID for the same fiscal year. In actual fact probably a much smaller percentage is included because of the lag between the time an AID-financed shipment leaves the United States, and the

time AID makes and records the payment for it. For the same reason, there is a high degree of congruity between Bureau of the Census pesticide export statistics and expenditures for AID-financed pesticide exports reported by AID in the following fiscal year. This basis of comparison has therefore been employed in Figure 3, page 30, and Tables 4 to 14, pages 31 to 32, 34 to 35, and 38 to 46.

Possible distortions due to these differences between Department of Commerce and AID records were minimized even further in the comparison between total United States and AID-financed exports in Tables 4 and 5. In these tables, 6-year averages of total United States pesticide exports for the calendar years 1969 to 1974 were compared to 6-year averages of AID-financed pesticide exports for FY 1970 to 1975. In the country-by-country comparisons of total pesticide use and total and AID-financed pesticide imports from the United States, 3-year totals for calendar years 1971 to 1973 were compared to 3-year totals for FY 1972 to 1974.

Expenditures for AID-financed pesticide exports include cost, insurance, and freight (c.i.f.) to destination, whereas the Bureau of the Census records values free alongside ship (f.a.s.) at the port of export. These differences exaggerate the share of AID-financed pesticide exports in comparison to total United States exports of pesticides by the amount of ocean freight and insurance. This distortion varies from product to product, depending upon product unit values and other factors.

Figure 3 and Tables 4 to 14 include all pesticides exported from the United States and financed by AID, i.e., those intended for food production (crop protection) as well as those intended for public health programs. More specific discussions of AID-financed pesticides for these two major uses are found on pages 48 to 57, and pages 57 to 63, respectively.

All of the AID-financed pesticides discussed in this chapter were exported from the United States. In addition, AID funds may be used for local purchases of pesticides as required on an ad-hoc basis within local or regional agricultural development projects. In such instances, pest control or management is only one of the means of accomplishing the overall rural development or crop or livestock production improvement objective. No historical records are available on the quantities, values, or kinds of pesticides purchased locally with AID funds and consequently, no data on past AID activities in this category can be presented. The information available on current and projected local pesticide purchases and uses financed or to be financed by AID funds is included in the section on AID's current and anticipated food production and preservation and public health programs in Chapter II (page 103).

AID-Financed and Total United States Pesticide Exports and Sales--

Tables 2 and 3 provide a perspective on the magnitude of AID-financed pesticide exports in relation to total United States pesticide exports and sales. Table 2 presents sales of United States-produced synthetic organic pesticides during the 6-year period 1969 through 1974 by value, including 6-year totals and averages per year. During each of the 6 years covered, the sales volume of herbicides exceeded that of insecticides and fungicides by considerable margins. The total sales volume of United States-produced synthetic organic pesticides increased from $851 million in 1969 to $1,815 million in 1974, an increase of 113%. In 1974, the most recent year covered, insecticides, herbicides, and fungicides accounted for 35.5, 57.7, and 6.8% of the total, respectively.

Table 3 compares AID-financed United States pesticide exports to total United States pesticide sales and exports for the same 6-year period. The volume of AID-financed exports varied considerably from year to year during this period; therefore, it is more useful to compare 6-year averages than data for individual years.

As indicated in the footnotes to Table 3, inorganic pesticides are not included in the United States sales figures, while they are included in the total United States and AID-financed export volumes. This discrepancy is due to the differences in the data collection methods and requirements of the U.S. International Trade Commission, which reports information on the United States production and sales of synthetic organic pesticides and related products, and those of the U.S. Bureau of the Census which reports export data. However, inorganic pesticides represent only about 1 and 6% of the value of total United States and AID-financed pesticide exports, respectively. Therefore, this discrepancy in the data bases does not distort the comparison appreciably.

Table 3 shows that during the 6-year period 1969 through 1974, the value of AID-financed pesticide exports averaged $17.5 million per year, which is 1.5% of the average annual value of all United States pesticide sales ($1.159 billion), and 5.7% of the average annual value of the United States pesticide exports ($308 million). Total United States as well as AID-financed pesticide exports contained a higher percentage of insecticides than total United States sales; AID-financed exports of insecticides represented 3.9 and 8.7% of total United States pesticide sales and exports, respectively.

Table 2: Sales[a/] of U.S.-Produced Synthetic Organic Pesticides

1969 - 1974 by Value

Calendar Year	Insecticides[b/]	Herbicides[c/]	Fungicides	Total
	$1,000			
1969	294,322	495,670	61,174	851,166
1970	307,182	497,954	65,178	870,314
1971	343,005	562,502	73,576	979,083
1972	380,586	628,958	82,164	1,091,708
1973	471,057	764,389	108,135	1,343,581
1974	644,862	1,047,668	122,903	1,815,433
Total	2,441,014	3,997,141	513,130	6,951,285
Average/Year	406,836	666,190	85,522	1,158,548

a/ Includes export sales.
b/ Includes insect attractants and repellents, fumigants, rodenticides, and soil conditioners.
c/ Includes plant growth regulators.
Sources: U.S. Department of Agriculture, ASCS (16);
U.S. International Trade Commission (17).

Table 3: AID-Financed U.S. Pesticide Exports Compared to Total U.S. Pesticide Sales and Exports, 1969-1974 (6-Year) Average, by Value

1969-1974 Avg./Year	Insecticides[a/]	Herbicides	Fungicides	Total
	$1,000			
U.S. Sales[b/]	406,836	666,190[c/]	85,522	1,158,548
U.S. Exports[d/]	181,368	89,912	36,769	308,049
AID-Financed Exports[d/]	15,723	1,317	480	17,520
AID-Financed Exports relative to -				
-- U.S. Sales	3.9%	0.2%	0.6%	1.5%
-- U.S. Exports	8.7%	1.5%	1.3%	5.7%

a/ Includes insect attractants and repellents, fumigants, rodenticides, soil conditioners, and miscellaneous pesticides.
b/ Does not include inorganic pesticides.
c/ Includes "plant hormones."
d/ Includes inorganic pesticides.
Sources: U.S. Department of Agriculture (16); U.S. International Trade Commission (17); AID (4); and RvR Consultants estimates.

AID-Financed and Total United States Pesticide Exports by Destination--

Figure 3 shows total United States and AID-financed pesticide exports by regions and values for the 11-year period 1964 through 1974, including technical and formulated pesticides. The value of all United States pesticide exports increased from about $135 million in 1964 and 1965 to $571 million in 1974. The value of AID-financed United States pesticide exports ranged from $11 million in 1974 to $34 million in 1968. The largest share of AID-financed pesticide exports went to Asia, smaller volumes went to Latin America, and the smallest shares of the total in most years went to Africa. Canada, Europe, Australia, and Oceania did not receive any AID-financed exports of United States pesticides.

The value of United States pesticide exports financed by AID in FY 1975, $10,984,000, represents 1.6% of the estimated total value of the pesticides used in developing market economies in 1974 (Table 1), and 0.16% of the value of the pesticides used worldwide in 1974.

A more detailed analysis of the value of total United States and AID-financed exports by destination for calendar years 1969 through 1974 (FY's 1970 through 1975) is presented in Table 4. All less developed countries that received significant amounts of AID-financed pesticides during this period are shown individually in this table, allowing a country-by-country comparison of total United States versus AID-financed exports.

For many less developed countries including Pakistan, India, Indonesia and others, Table 4 shows considerable variations from year to year in the value of total as well as AID-financed pesticides imported from the United States. This does not indicate corresponding ups and downs in total pesticide use in the countries concerned, but changes in the sources of supply resulting from world competition in the pesticide market or individual country preferences for specific pesticides, suppliers, or donors.

Total United States pesticide exports to all countries averaged $308 million per year during calendar years 1969 to 1974 (Column G, Table 4). Of this total, $168 million (55%) were exported to developed market economies or to centrally planned economies, including Canada, Europe, Australia, and Oceania, South Africa, Japan, Hong Kong, and the People's Republic of China (abbreviated "China M"). Total United States pesticide exports to developing market economies averaged $140 million per year, equivalent to 45% of the total annual 6-year average. AID-financed United States pesticide exports averaged $17.5 million per year, or 5.7% of the average annual total United States exports, and 12.5% of the average annual United States pesticide exports to less developed countries (except centrally planned economies). AID did not finance any pesticide exports to developed countries, with the exception of Israel.

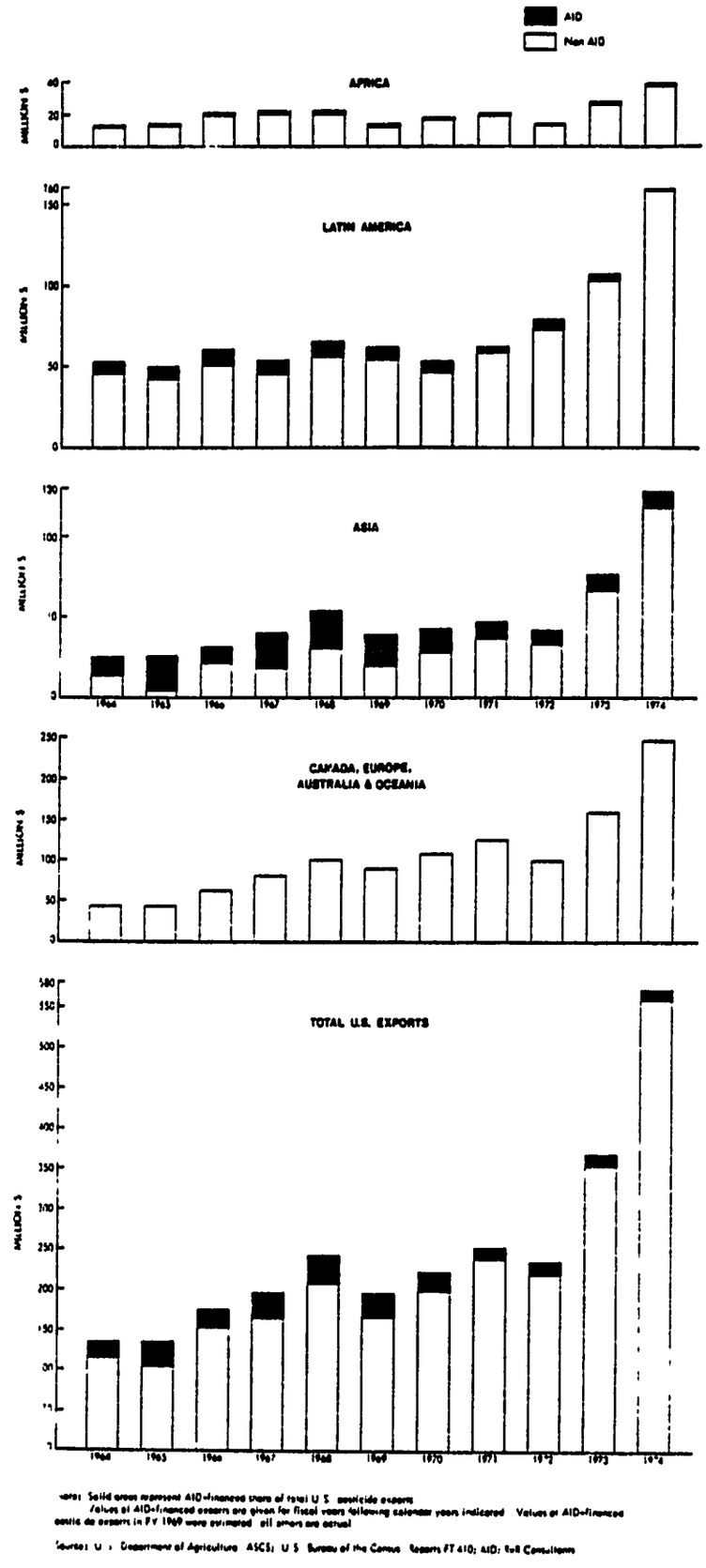

Figure 3 - Total United States and AID-Financed Pesticide Exports by Regions and Values, 1964 to 1974

Table 4: U.S. Pesticide Exports by Destination and Value:
Total Exports in Calendar Years 1969-1974 Compared to AID-Financed Exports in Fiscal Years 1970-1975

Country	Total U.S. Exports ($000)							AID-Financed Exports ($000)							AID Share N/G
	CY 1969	CY 1970	CY 1971	CY 1972	CY 1973	CY 1974	Avg./ Year	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974	FY 1975	Avg./ Year	
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Africa															
Tunisia	NA	25	105	56	79	93	72	420	33	27	46	-	-	21	29.2%
Liberia	NA	129	139	82	77	89	103	1	-	-	-	-	-	Negl.	Negl.
Ghana	NA	55	29	13	158	150	81	7	-	-	24	4	-	6	7.4%
Nigeria	NA	NA	NA	19	81	642	247	2	-	-	-	-	-	Negl.	Negl.
Ethiopia	NA	56	673	199	656	623	441	1,175	756	552	470	1,397	871	809	100% +
Tanzania	NA	NA	NA	165	317	621	367	-	-	-	-	2	-	Negl.	Negl.
S. Africa	5,986	7,113	8,751	4,989	9,164	16,646	8,775	-	-	-	-	-	-	-	0%
All Others	balance	balance	balance	9,190	17,020	19,345	NA	-	-	-	-	-	5	1	NA
Total	14,237	17,573	19,952	14,713	27,552	38,209	22,039	1,605	789	579	540	1,403	876	965	4.4%
Asia															
Israel	NA	NA	NA	789	1,462	3,330	1,860	-	-	-	589	242	383	405	21.8%
Pakistan	7,773	13,080	2,033	21	644	3,302	4,476	10,691	8,770	1,591	306	255	1,891	3,917	87.5%
India	2,527	2,974	7,557	2,756	7,638	11,281	5,789	4,559	3,291	3,847	2	694	268	2,110	36.4%
Nepal	NA	NA	NA	196	130	190	172	486	289	196	130	217	-	116	67.4%
Bangladesh	NA	NA	NA	1,437	65	-	501	-	-	-	1,863	-	-	621	100% +
Sri Lanka	NA	102	265	303	129	279	216	417	-	-	-	-	-	NA	NA
Thailand	4,403	2,525	2,444	2,500	5,345	4,575	3,632	2,032	-	-	-	-	-	339	9.3%
Cambodia	NA	NA	NA	-	-	168	56	-	-	-	4	28	29	20	35.7%
S. Vietnam	714	1,318	2,344	4,288	3,424	4,743	2,805	589	1,929	3,013	4,440	4,491	6,330	3,465	100% +
Indonesia	NA	878	542	1,786	2,880	14,618	4,141	225	528	813	1,300	4,106	1,021	1,554	37.5%
Philippines	1,251	1,792	2,228	2,532	6,442	9,535	3,963	189	138	24	60	-	-	69	1.7%
S. Korea	NA	1,068	1,532	2,699	3,915	2,402	2,323	-	130	-	-	-	-	26	1.1%
Japan	11,677	9,327	16,961	11,926	22,600	43,374	19,311	-	-	-	-	-	-	-	0%
China T	NA	NA	NA	2,142	4,817	6,463	4,474	-	-	-	-	-	-	-	0%
China M	NA	NA	NA	-	1,889	2,251	1,380	-	-	-	-	-	-	-	0%
Hong Kong	NA	NA	NA	1,779	3,296	3,234	2,770	-	-	-	-	-	-	-	0%
All Others	balance	balance	balance	6,743	11,206	17,694	NA	1	4	-	3	-	54	10	NA
Total	38,578	42,460	46,283	41,897	75,882	127,439	62,090	19,189	15,079	9,484	8,697	10,033	9,976	12,076	19.4%

Table 4: U.S. Pesticide Exports by Destination and Value:
(concluded) Total Exports in Calendar Years 1969-1974 Compared to AID-Financed Exports in Fiscal Years 1970-1975

Country	Total U.S. Exports ($000)							Aid-Financed Exports ($000)							AID Share N/G
	CY 1969	CY 1970	CY 1971	CY 1972	CY 1973	CY 1974	Avg./ Year	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974	FY 1975	Avg./ Year	
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Latin America															
Dom. Republic	NA	NA	NA	1,160	2,365	3,029	2,185	219	-	-	-	-	2	Negl.	Negl.
Nicaragua	3,478	3,315	3,792	5,454	10,825	11,570	6,406	235	904	840	937	574	-	582	9.1%
Costa Rica	2,395	2,405	2,812	4,162	5,131	7,902	4,135	14	-1	-	-	-	-	2	Negl.
Colombia	8,486	8,538	9,698	9,356	11,360	18,714	11,025	2,678	3,417	64	283	-	-	1,074	9.7%
Paraguay	NA	210	374	15	33	29	132	-	267	62	-	-	-	55	41.7%
Uruguay	NA	NA	NA	156	1,161	946	754	-	-	242	-	-	-	NA	NA
Brazil	8,661	10,918	10,487	19,397	30,197	51,353	21,836	3,997	2,083	1,876	4,299	3,139	-	2,566	11.8%
Chile	NA	833	331	422	372	703	532	149	18	11	-	-	-	6	1.1%
Mexico	14,325	5,018	10,554	12,386	14,006	17,923	12,369	-	-	-	-	-	-	-	0
All Others	balance	balance	balance	25,670	31,117	46,350	NA	-	-	43	135	250	130	NA	NA
Total	61,405	52,560	61,322	78,178	106,567	158,519	86,425	7,292	6,688	3,138	5,654	3,963	132	4,478	5.2%
Canada	23,371	17,318	18,960	24,797	35,865	56,412	29,454	-	-	-	-	-	-		0
Europe	55,981	83,983	97,457	63,524	105,422	162,155	94,754	-	-	-	-	-	-		0
Australia, New Zeald., Oceania	9,249	6,419	7,628	6,703	15,054	25,813	11,811	-	-	-	-	-	-		0
NEC	-	-	-	2,635	2,446	2,112	NA	-	-	-	-	-	-		0
Grand Total	202,821	220,313	251,602	232,447	368,788	570,659	307,772	28,086	22,556	13,201	14,891	15,399	10,984	17,520	5.7%

Notes: CY = Calendar Year, FY = Fiscal Year, NA = Not available, Negl. = Negligible, NEC = Not elsewhere classified.
Averages/year: Where data for 6 comparable calendar/fiscal years were not available, averages/year are given only for the comparable years. See text.

Sources: U.S. Bureau of the Census, Reports FT410; AID; RvR Consultants.

Less developed countries in Asia received by far the largest share of AID-financed pesticides, namely 19% of all United States pesticide exports to that continent (Column O, Table 4), and 69% of all AID-financed pesticide exports. AID-financed United States pesticide exports to Pakistan averaged $3.9 million per year (87.5% of all United States pesticide exports to that country). South Vietnam received an average of $3.5 million worth of AID-financed pesticides per year, that is $660,000 more than the average annual value of all United States pesticide exports to that country. This apparent inconsistency may be due to reporting deficiencies or because the AID figure for FY 1975 ($6,330,000) may have included substantial shipments not recorded by the Bureau of the Census in calendar year 1974.

For two other countries, Ethiopia and Bangladesh, the average annual value of AID-financed pesticide exports also exceeded the reported average annual value of total United States pesticide exports. In both of these cases, the total United States export averages are based on less than 6 years, which probably is the reason for the discrepancies.

In addition to Pakistan and South Vietnam, countries receiving AID-financed United States pesticides averaging more than $1 million per year include (in descending order of average annual value of AID-financed United States pesticides received) Brazil, India, Indonesia, and Colombia.

In addition to South Vietnam, Ethiopia, and Bangladesh, countries receiving more than 50% of their total shipments of pesticides from the United States through AID financing were Pakistan and Nepal.

Table 4 includes a total of 25 less developed countries that received United States pesticides financed by AID in one or more years between 1969 and 1974. For 13 of these countries, i.e., Liberia, Ghana, Nigeria, Tanzania, Thailand, Philippines, South Korea, Dominican Republic, Nicaragua, Costa Rica, Colombia, Uruguay, and Chile, AID financing provided less than 10% of each country's total receipts of United States pesticides.

AID-Financed and Total United States Pesticide Exports by Product Groups--

Table 5 summarizes data on total United States and AID-financed pesticide exports by technical active ingredients, formulations, functions (insecticides, herbicides, etc.), and by the product classifications of the U.S. Bureau of the Census export statistics. Comparisons are made on the same basis and for the same time periods as in Table 4.

For the 6-year period covered, AID-financed exports amounted to 9.7% of the value of all United States exports of technical and formulated insecticides, 1.5% of all herbicide exports, 1.3% of all fungicide exports, and 1.9% of all exports of other pesticides including rodenticides, fumigants, and disinfectants.

Table 5: U.S. Pesticide Exports by Product Groups and Value:
Total Exports in Calendar Years 1969-1974 Compared to AID-Financed Exports in Fiscal Years 1970-1975

Product Group	Total U.S. Exports ($000)							AID-Financed Exports ($000)							AID Share M/G
	CY 1969	CY 1970	CY 1971	CY 1972	CY 1973	CY 1974	Avg./ Year	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974	FY 1975	Avg./ Year	
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Insecticides, tech.															
DDT	3,876	2,433	3,187	4,750	10,861	15,038	6,691	517	645	217	399	264	923	494	7.4%
Aldrin-toxaph. group	12,130	12,633	16,375	15,007	23,829	32,757	18,789	393	1,689	1,964	228	771	617	944	5.0%
Other poly-Cl	3,030	4,129	2,789	3,313	2,063	4,094	3,236	568	1,371	97	790	-	-	471	14.6%
Parathions	7,900	4,920	7,951	7,446	4,082	8,546	6,808	47	211	119	160	-	-	90	1.3%
Other org. phosph.'s	28,103	22,508	23,129	24,681	40,339	74,938	35,616	3,369	3,732	3,021	3,669	3,061	2,110	3,160	8.9%
Other insecticides															
- organic	16,228	20,660	34,692	25,277	37,784	51,136	30,963	432	719	1,103	1,118	842	2,521	1,122	3.6%
- inorganic	1,758	1,078	944	523	1,292	1,254	1,142	203	228	480	886	2,590	122	752	65.8%
Subtotal technical	73,025	68,361	89,067	80,997	120,250	187,763	103,244	5,529	8,595	7,001	7,250	7,528	6,293	7,033	6.8%
Insecticides, form.															
DDT 75% & above	9,755	11,412	6,284	737	3,979	2,777	5,824	10,963	8,499	4,120	4,869	3,002	442	5,316	91.3%
DDT below 75%	1,015	521	572	1,061	1,296	961	904	5,382	86	30	68	139	-	951	100% +
Other poly-Cl	4,796	3,838	3,931	5,413	5,705	15,785	6,578	458	293	-	125	2,204	800	647	9.8%
Org. phosphates	4,290	11,748	17,231	12,545	22,785	28,574	16,196	-	764	491	19	454	676	401	2.5%
Househ. & industr.	5,722	9,216	7,737	6,842	11,594	14,544	9,276	1,522	64	103	436	77	29	372	4.0%
Other insecticides	9,731	13,945	11,844	8,930	20,573	27,236	15,377	1,680	209	234	307	659	273	560	3.6%
Subtotal form.'s	35,309	50,680	47,598	35,528	65,932	89,877	54,154	20,005	9,915	4,978	5,824	6,535	2,220	8,246	15.2%
Total Insecticides	108,333	119,041	136,665	116,525	186,182	277,640	157,398	25,534	18,510	11,979	13,074	14,063	8,513	15,279	9.7%
Herbicides, tech.															
Phenoxy prod.'s	2,400	3,305	3,802	2,709	8,581	12,443	5,540	-	741	197	178	197	-	219	4.0%
Other herbicides															
- organic	26,046	29,615	25,042	29,482	41,598	66,247	36,338	1,532	648	193	104	163	39	446	1.2%
- inorganic	1,245	495	448	154	203	548	516	-	21	-	-	-	-	4	0.8%
Subtotal technical	29,691	33,415	29,292	32,345	50,382	79,238	42,394	1,532	1,410	390	282	360	39	669	1.6%
Formulations	29,508	28,725	36,627	35,970	53,934	100,345	47,518	284	1,830	448	1,009	187	131	648	1.4%
Total Herbicides	59,199	62,140	65,919	68,315	104,316	179,583	89,912	1,816	3,240	838	1,291	547	170	1,317	1.5%

Table 5: : U.S. Pesticide Exports by Product Groups and Value:
(concluded) Total Exports in Calendar Years 1969-1974 Compared to AID-Financed Exports in Fiscal Years 1970-1975

Product Group	Total U.S. Exports ($000)							AID-Financed Exports ($000)							AID Share M/G
	CY 1969	CY 1970	CY 1971	CY 1972	CY 1973	CY 1974	Avg./ Year	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974	FY 1975	Avg./ Year	
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Fungicides, tech.															
- organic	4,527	4,336	5,284	5,154	7,228	11,366	6,316	48	28	-	-	121	207	67	1.1%
- inorganic	2,385	1,543	2,078	1,767	2,043	2,138	1,992	14	29	-	3	-	-	8	0.4%
Subtotal technical	6,912	5,879	7,362	6,921	9,270	13,504	8,308	62	57	-	3	121	207	75	0.9%
Fungicides, form.															
Captan, mercurials	560	1,159	759	481	926	1,551	906	3	17	-	-	2	-	4	0.4%
Dithiocarbamates	2,465	4,442	3,854	4,882	5,536	9,160	5,057	18	464	306	385	339	141	275	5.4%
Others	9,755	12,258	20,549	13,872	31,813	46,744	22,498	63	37	72	25	210	348	126	0.6%
Subtotal form.'s	12,780	17,859	25,162	19,235	38,275	57,455	28,461	84	518	378	410	551	489	405	1.4%
Total Fungicides	19,691	23,738	32,524	26,156	47,545	70,959	36,769	146	575	378	413	672	696	480	1.3%
Other Pesticides,															
- technical															
Rodenticides	448	127	107	375	253	210	253	-	-	-	-	41	-	7	2.8%
Fumigants	6,886	5,514	6,595	6,896	7,362	11,340	7,432	229	181	6	-	12	79	85	1.1%
Disinfectants, etc.	3,696	4,825	4,294	4,073	5,438	8,048	5,062	-	-	-	-	-	-	-	0%
Other pesticides															
- organic	-	-	1,666	4,207	3,264	4,055	2,199	9	-	-	-	23	-	5	0.2%
- inorganic	NA	NA	NA	NA	NA	NA	NA	-	-	-	-	-	1,526	254	NA
Subtotal technical	11,030	10,466	12,662	15,551	16,317	23,653	14,946	238	181	6	-	76	1,605	351	2.3%
- formulations															
Disinfectants, etc.	2,870	2,545	2,505	2,227	2,478	3,330	2,659	347	-	-	-	-	-	58	2.2%
Dips, growth reg.'s	1,698	2,384	2,992	3,673	11,950	15,494	6,365	5	50	-	113	41	-	35	0.5%
Subtotal form.'s	4,568	4,929	5,497	5,900	14,428	18,824	9,024	352	50	-	113	41	-	93	1.0%
Total other pestic.'s	15,597	15,395	18,159	21,451	30,745	42,477	23,971	590	231	6	113	117	1,605	444	1.9%
All Pesticides	202,821	220,313	253,268	232,447	368,788	570,659	308,049	28,086	22,556	13,201	14,891	15,399	10,984	17,520	5.7%

Notes: CY = Calendar Year FY = Fiscal Year NA = Not available

Sources: U.S. Bureau of the Census, Reports FT 410; U.S. Dept. of Agriculture, ASCS; AID; RvR Consultants.

These data show that AID financed a relatively larger share of all insecticides exported from the United States and a smaller share of exports of all other types of pesticides. This is due, at least in part, to the fact that AID-financed pesticide exports included sizeable shipments of DDT 75% wettable powder (and small amounts of other DDT formulations and other insecticides) for antimalaria programs (see page 58).

For DDT formulations containing less than 75% of active ingredient, the average annual value of AID-financed shipments ($951,000, Column N, Table 5) exceeds the value of all United States export shipments for the study period ($904,000, Column G). Examination of AID expenditures for "DDT below 75%" in FY 1970 (Column H) in comparison to total United States exports of this item in CY 1969 (same line, Column A) suggests a possible explanation for this inconsistency, i.e., the AID figure for FY 1970 may include expenditures for shipments that left the United States prior to CY 1969.

In addition to DDT, AID-financed insecticides included relatively large volumes of organic phosphates other than parathion or methyl parathion, chlorinated insecticides other than DDT, and carbamates. (See Table 15, page 50 and Appendix B for more detailed historical data on AID-financed pesticide exports by quantities of individual active ingredients.)

Technical and formulated insecticides made up 87% of the value of all AID-financed United States pesticide exports during the 6-year period covered in Table 5. AID-financed pesticides averaged $15.3 million of a total of $17.5 million per year. The balance consisted of herbicides ($1.3 million per year, 7.5%), fungicides ($480,000/year, 2.7%), and other pesticides including rodenticides, fumigants, disinfectants, etc. ($444,000/year, 2.5%).

This pesticide use pattern is consistent with the observations of the University of California Pest Management Study Teams (page 64), with the FAO survey on pesticide requirements (page 21), and with other reports on pesticide uses in less developed countries. These sources report uniformly that these countries currently use insecticides in much larger quantities than other types of pesticides. The use of herbicides generally increases only with increasing agricultural mechanization. Fungicides, rodenticides, fumigants, and disinfectants apparently ranged low in priority in the needs of less developed countries receiving AID-financed United States pesticides.

AID-Financed and Total Pesticide Use in Nine Selected Countries--

The fact that AID-financed pesticides represent only a small fraction (1.6%) of the estimated total value of the pesticides used in less developed countries has been discussed above (see Table 1, page 23, and page 29). However, further definition and quantification of the relationships between AID-financed exports to less developed countries and the total quantities of pesticides used in these countries are very difficult because of limitations and deficiencies in the data. Review of available data sources (including United Nations, FAO, WHO, U.S. Department of Commerce, U.S. Department of Agriculture, and AID) showed that for 9 of the 18 less developed countries that received AID-financed pesticides between 1971 and 1973, sufficient data were available for an analysis by source of all versus AID-supplied pesticides used. For each of these nine countires, Tables 6 through 14 present annual and total quantities of pesticides used in the years 1971 to 1973, broken down by function, as reported to FAO; volume and value of all pesticides imported from the United States during the same period, as reported by the U.S. Bureau of the Census; and value of AID-financed pesticides for FY's 1972 to 1974.

The relationships between expenditures for pesticides reported by AID by fiscal years and United States pesticide exports reported by the U.S. Bureau of the Census by calendar years are discussed on page 24. The FAO survey on pesticide requirements in developing countries reports pesticide uses by quantities, while AID-financed pesticide exports were reported by value. The U.S. Bureau of the Census reports pesticide exports from the United States both by quantity and by value. Thus, total United States pesticide exports can be compared to total in-country pesticide use by quantities (Tables 6 through 14, Columns D and H), and to the share financed by AID by value (Columns L and P). However, direct comparisons between AID-financed pesticide imports from the U.S. and total pesticide use in each country (Column P:Column D) are not possible, due to these differences in reporting units.

It is emphasized that the comparisons in Tables 6 through 14 provide only approximations at best; their precision leaves much to be desired. For example, the FAO survey reports that in 1973, the Philippines imported 2,891 MT of pesticide active ingredients. A paper presented at the FAO/UNEP Expert Consultation on Impact Monitoring of Residues Due to the Use of Agricultural Pesticides held at Rome, Italy in 1975, reported that 4,096.7 MT of agricultural pesticides were imported into the Philippines in 1973 (19).

Table 6: Pesticide Use in Ethiopia, 1971 - 1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio H/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	-	35	58	93	-	-	-	-	-	-	-	-	-	-	-	-	0%	-
Insecticides	-	-	534	534	1,247	113	1,008	2,368	667	199	656	1,522	552	470*	890* 507	2,419	100%+	100%+
Fungicides	-	-	13	13	-	-	-	-	-	-	-	-	-	-	-	-	0%	-
Total	-	35	605	640	1,247	113	1,008	2,368	667	199	656	1,522	552	470	1,397	2,419	100%+	100%+

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

* Insecticides for Antimalaria Programs (not included in Columns A-D).

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4); RvR Consultants estimates.

Table 7: Pesticide Use in India, 1971 - 1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio H/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	645	860	1,160	2,665	198	160	1,217	1,575	333	133	741	1,207	161	2	-	163	59%	14%
Insecticides	20,243	24,576	32,236	77,055	7,668	2,241	5,633	15,542	7,130	2,513	6,664	16,307	3,686	-	694	4,380	20%	27%
Fungicides	4,303	5,920	6,696	16,919	15	8	22	45	44	36	54	134	-	-	-	..	0.3%	0%
Total	25,191	31,356	40,092	96,639	7,881	2,409	6,872	17,162	7,507	2,682	7,459	17,648	3,847	2	694	4,543	18%	26%

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4); RvR Consultants.

Table 8: Pesticide Use in Nepal, 1971 - 1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio H/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
Insecticides	7	9	14	30	-	413	292	705	-	196	130	326	196*	130*	217*	543*	100%+	100%+
Fungicides	3	3	1	7	-	-	-		-	-	-	-	-	-	-	-	-	-
Total	10	12	15	37	-	413	292	705	-	196	130	326	196	130	217	543	100%+	100%+

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

* Insecticides for Antimalaria Programs (not included in Columns A-D).

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4); RvR Consultants estimates.

Table 9: Pesticide Use in Indonesia, 1971 - 1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio H/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	891	2,009	1,826	4,726	23	524	523	1,070	81	1,034	317	1,432	270	455	228	953	23%	67%
Insecticides	2,239	1,700	2,755	6,694	79	669	2,137	2,885	132	435	2,181	2,748	165	559	3,550	4,274	43%	100%+
Fungicides	299	449	601	1,349	209	179	274	662	288	203	333	824	372	286	287	945	49%	100%+
Total	3,429	4,158	5,182	12,769	311	1,372	2,934	4,617	501	1,672	2,831	5,004	807	1,300	4,065	6,172	36%	100%+

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4); RvR Consultants.

Table 10: Pesticide Use in the Philippines, 1971 - 1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio H/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	200	450	931	1,581	233	171	358	762	480	217	915	1,612	-	-	-	-	48%	0%
Insecticides	336	643	1,879	2,858	624	857	2,365	3,846	610	771	3,513	4,894	10* 14	60*	-	84	100%+	2%
Fungicides	47	60	81	188	984	1,409	1,350	3,743	696	1,309	1,582	3,587	-	-	-	-	100%+	0%
Total	583	1,153	2,891	4,627	1,841	2,437	4,073	8,351	1,786	2,297	6,010	10,093	24	60	-	84	100%+	0.8%

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

* Insecticides for Antimalaria Programs.

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4): RvR Consultants estimates.

Table 11: Pesticide Use in S. Vietnam, 1971-1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio H/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	60	440	179	679	146	225	140	511	110	198	126	434	220	165	227	612	75%	100%+
Insecticides	979	1,338	1,240	3,557	2,043	4,526	1,554	8,123	2,092	3,805	3,091	8,988	69* 2,724	4,275	4,147	11,215	100%+	100%+
Fungicides	83	216	181	480	10	175	182	367	12	272	171	455	-	-	117	117	76%	26%
Total	1,122	1,994	1,600	4,716	2,199	4,926	1,876	9,001	2,214	4,275	3,388	9,877	3,013	4,440	4,491	11,944	100%+	100%+

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

* Insecticides for Antimalaria Programs.

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4); RvR Consultants estimates.

Table 12: Pesticide Use in Chile, 1971 - 1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio H/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	418	478	597	1,493	39	24	10	73	83	45	26	154	9	-	-	9	5%	6%
Insecticides	1,136	2,669	2,454	6,259	122	245	228	595	138	258	216	612	2	-	-	2	10%	0.3%
Fungicides	4,175	4,521	7,344	16,040	10	48	57	115	55	119	130	304	-	-	-	-	0.7%	0%
Total	5,729	7,668	10,395	23,792	171	317	295	783	276	422	372	1,070	11	-	-	11	3%	1%

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4); RvR Consultants.

Table 13: Pesticide Use in Paraguay, 1971 - 1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio H/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	10	-	-	10	12	-	-	12	62	-	-	62	62	-	-	62	100%+	100%
Insecticides	211	269	175	655	301	10	8	319	284	15	15	314	-	-	-	-	49%	0%
Fungicides	0	15	10	25	-	-	2	2	-	-	18	18	-	-	-	-	8%	0%
Total	221	284	185	690	313	10	10	333	346	15	33	394	62	-	-	62	48%	16%

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4); RvR Consultants.

Table 14: Pesticide Use in Uruguay, 1971 - 1973: Total Use Compared to Total and AID-Financed Imports from the U.S., by Classes of Pesticides

Pesticide Class a/	Total Use				Imports from the U.S.												Ratio N/D	Ratio P/L
					Total								AID-Financed					
	Metric Tons b/				Metric Tons c/				$1,000				$1,000					
	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	CY71	CY72	CY73	Total	FY72	FY73	FY74	Total		
Column	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Herbicides	20	68	121	209	20	23	101	144	62	30	193	285	-	-	-	-	69%	0%
Insecticides	70	163	159	392	180	21	52	253	284	69	143	496	242	-	-	242	65%	49%
Fungicides	376	711	1,111	2,198	-	15	157	172	-	27	760	787	-	-	-	-	8%	0%
Total	466	942	1,391	2,799	200	59	310	569	346	126	1,096	1,568	242	-	-	242	20%	15%

a/ Pesticides other than herbicides, insecticides and fungicides not included.

b/ Active ingredients.

c/ Primarily active ingredients, but includes some formulated materials.

Sources: FAO (11); U.S. Bureau of the Census (18); AID (4); RvR Consultants.

Other inconsistencies are evident in several of the nine tables. In three countries (Ethiopia, Nepal, and South Vietnam, Tables 6, 8, and 11, respectively) pesticide imports from the United States (Column H) exceed total reported in-country pesticide use (Column D), causing the Column Q total to exceed 100%. Possible reasons for this overage include one or more of the following:

* Columns E through H may include large amounts of low-concentrate formulations or insecticides for antimalaria programs not included in Columns A through D.

* In-country pesticide use underestimated.

* Export of pesticides supplied by the United States or others.

* Pesticides imported from the United States not used during the period 1971 to 1973.

* Misreporting.

For four countries (Ethiopia, Nepal, Indonesia, and South Vietnam), the value of AID-financed pesticides in FY's 1972 to 1974 exceeds the value of total pesticide imports from the United States in calendar years 1971 to 1973 (Column R total exceeds 100%). Possible reasons for this include:

* Payments reported by AID in FY's 1972 to 1974 (Columns M to P) not included in Bureau of the Census Reports for calendar years 1971 to 1973 (Columns I to L).

* Misreporting.

Thus, the data in Tables 6 to 14 should not be over-interpreted. The following observations are offered with this caveat.

For three countries, South Vietnam, Ethiopia, and Nepal, essentially all pesticides used were imported from the United States and financed by AID. In South Vietnam, pesticides used included substantial quantities of insecticides, and somewhat smaller quantities of herbicides and fungicides, all apparently used primarily for crop protection. Less than 1% (by value) of the insecticides supplied by AID to South Vietnam during the 3-year period covered were supplied for malaria control purposes. (Insecticides supplied for antimalaria programs are identified by asterisks in Tables 6, 8, 10, and 11; see also Table 22, page 60). Ethiopia and Nepal received AID-financed insecticides, but no herbicides or fungicides. All of the AID-supplied insecticides for Nepal and more than one-half of those supplied

to Ethiopia were intended for malaria control programs. Agricultural use of pesticides is apparently very small in both countries, although the FAO data show a beginning buildup in Ethiopia in 1972 to 1973.

Table 9 indicates that in Indonesia, all of the pesticides imported from the United States during the period 1971 to 1973 were financed by AID, but these represented only 36% of all pesticides used in the country during that period. In the remaining five countries, i.e., India, Philippines, Chile, Paraguay, and Uruguay (Tables 7, 10, 12, 13, and 14, respectively), AID-financed pesticides represented less than 10% of all pesticides used from 1971 to 1973.

Table 7 indicates that between 1971 and 1973, India used nearly 100,000 MT of pesticides, but only 18% of this total was imported from the United States, and only 26% of these imports were financed by AID. India probably imported pesticides from countries other than the United States during this period. However, a recent report on Indian production, consumption and use of pesticides indicates that India currently produces 39 technical-grade pesticides domestically, including 17 insecticides (DDT, BHC, toxaphene, malathion, fenitrothion, Metasystox, and ethyl and methyl parathion among them); 14 fungicides including mercurials, copper salts, sulfur preparations, and several dithiocarbamates; three herbicides (2,4-D, 2,4,5-T, and ammonium sulfamate); three rodenticides; one molluscicide, and one nematocide (27). AID field reports indicate that India produced at least 65% (by value) of all pesticides it used in 1969 and planned to further increase its domestic pesticide manufacturing capabilities.

Table 10 indicates that all of the pesticides used in the Philippines in the period 1971 to 1973 were imported from the United States, but AID financed less than 1% of these imports, i.e., a total of $84,000 worth of insecticides intended primarily for malaria control. In the case of Chile, Paraguay, and Uruguay (Tables 12 to 14), pesticides imported from the United States represented 3, 48, and 20% of total pesticide use, and AID financed 1, 16, and 15% of the pesticides imported from the United States, respectively.

Pesticides Financed by AID for Food Production Purposes

Analysis by Active Ingredients and Quantities--

For FY's 1973 to 1975 and 9 months of FY 1976, data on AID-financed pesticides exported from the United States are available by quantities, broken down by individual pesticide active ingredients. Pesticides financed by AID for public health programs during this period are included in the discussion beginning on page 57. Pesticides financed for food production (crop protection) purposes are discussed in this section.

Table 15 lists all pesticides financed by AID from July 1972 through March 1976 by active ingredient, in decreasing order of quantity of active ingredient. A total of 67 different pesticides were supplied in quantities totaling 8,917 MT. In addition, AID financed small quantities of pesticide products containing active ingredients not identified in the available records or unknown amounts of active ingredients, and of pesticide intermediates, solvents, emulsifiers, synergists, etc. (More detailed data on these items are included in Appendix B.)

Table 16 presents an analysis of the number of pesticides financed by AID in FY 1973 through March 1976 by historical eligibility status and quantity ranges. The December 16, 1974, AID Commodity Eligibility Listing included 92 pesticide active ingredients, many available as technical and/or in one or more different formulations (see page 17). Of these, 66 active ingredients were considered "AID-approved," while the remaining 26 were designated as "conditionally eligible," requiring special handling procedures. By comparison, 67 different pesticide active ingredients were actually financed by AID in FY 1973 through March 1976. Of these, 27 were "AID-approved," 20 were "conditionally eligible," and 20 were not included in the 1974 listing.

The breakdown by quantities in Table 16 indicates that more than one-half of the conditionally eligible pesticides, and all but one of the pesticides not listed were supplied in quantities under 50 MT (about 110,000 lb) of active ingredient over the entire 3-3/4 year period covered.

Table 17 presents an analysis by product of the pesticides purchased by AID in FY 1973 through March 1976 in quantities over 50 tons. These pesticides are broken down by function, chemical group (insecticides only), and eligibility status. In each subcategory, the pesticides are listed in decreasing order of total quantity of active ingredient supplied. The list includes 16 insecticides (6 organochlorines, 7 organophosphates, and 3 carbamates), 4 herbicides, 3 fungicides, and 1 fumigant, 24 pesticides in all.

Operational Details--

In most instances, AID assistance in financing pesticides was provided either under General Commodity Import Programs, or as Project Assistance. (See page 18 for a brief description of the administrative procedures that were involved in each type of financing.)

Tables 18 to 20 present summaries of the steps that were involved in each of three typical modes of financing, and minimum and maximum time periods required to complete the different steps and the entire transaction from initiation of the request to availability of the pesticide to the end user, based on actual experience.

Table 15: Pesticides Financed by AID 1972-1976 by Quantities of Active Ingredient[a]

Pesticide	Metric Tons Active Ingredient	Previous Eligibility Status[b]
1. Diazinon	1,280	a
2. DDT	905	b
3. Carbaryl	792	a
4. MSMA	727	b
5. Toxaphene	484	a
6. Mancozeb	478	a
7. Malathion	473	a
8. 2,4-D	434	a
9. Monocrotophos	389	b
10. Dichlorvos	324	a
11. BHC	322	b
12. Endrin	276	b
13. Maneb	266	a
14. Methyl parathion	203	b
15. Naled	178	a
16. Propanil	136	a
17. Carbofuran	126	b
18. Ethylene dichloride	113	c
19. Heptachlor	110	b
20. Dalapon-Na	102	a
21. Chlordane	87	a
22. Zineb	76	a
23. Methomyl	65	b
24. Leptophos	64	a
25. Methamidophos	42	b
26. Chlorothalonil	40	a
27. Methyl bromide	33	b
28. Cycloate	29	c
29. Dacthal	29	c
30. Benomyl	29	a
31. Zinc phosphide	27	b
32. Noruron (norea)	24	c
33. Dicrotophos	24	b
34. Ethyl parathion	22	c
35. Mirex	21	c
36. Captan	17	a
37. Acephate	17	a
38. Phosphamidon	16	c
39. Carboxin	15	c
40. Aldicarb	13	c
41. Dicofol	13	a
42. Atrazine	11	a
43. Calcium cyanide	9.8	b

Table concluded on following page

Table 15 (Concluded): Pesticides Financed by AID 1972-1976 by Quantities of Active Ingredient[a]

Pesticide	Metric Tons Active Ingredient	Previous Eligibility Status[b]
44. o-Phenylphenol	8.3	c
45. Tetrachlorvinphos	7.9	a
46. Lindane	7.3	b
47. Thiabendazole	6.6	c
48. Ethion	6.3	a
49. DSMA	5.6	b
50. Vernolate	5.3	c
51. EPTC	5.2	a
52. PCNB	5.1	a
53. Carbophenothion	4.2	b
54. Diethyl toluamide	3.3	c
55. Difenzoquat	2.3	c
56. Bensulide	2.0	c
57. Dieldrin	.9	b
58. Ethephon	.8	c
59. Ametryne	.8	a
60. Lethane 384	.8	c
61. Chloropicrin[c]	.7	b
62. Amiben	.6	c
63. Diuron	.4	a
64. Diphacinone	.2	b
65. Napropamide	.1	c
66. Dinocap	.1	a
67. Mercuric chloride	.05	c
Total	8,917	

a/ Table includes all pesticides financed by AID except for DDT used in malaria control programs from July 1972 through March 1976, listed in decreasing order of quantity of active ingredient.

b/ Eligibility status (per Commodity Eligibility Listing dated December 16, 1974) symbols:

a = AID-Approved; *b* = Conditionally Eligible; *c* = Not Listed

The use of this eligibility listing was discontinued when the interim regulations on pesticide procurement became effective.

c/ As a mixture with methyl bromide.

Source: AID (20).

Table 16: Number of Pesticides Purchased by AID 1972-1976 by Historical Eligibility Status[a] and Quantities

	Number of Pesticides (Active Ingredients)			
	AID-Approved	Conditionally Eligible	Not Listed	Totals
Pesticides included in Commodity Eligibility Listing of Dec. 16, 1974	66	26	--	92
Pesticides actually purchased 1972-1976[b] in quantities -				
- over 1,000 tons[c]	1	0	0	1
- 500 - 999 tons	1	2	0	3
- 100 - 499 tons	9	6	1	16
- 50 - 99 tons	3	1	0	4
- 10 - 49 tons	6	4	8	18
- under 10 tons	7	7	11	25
Total	27	20	20	67

Notes: a/ Eligibility for AID financing per AID Commodity Eligibility Listing of pesticides dated December 16, 1974.

b/ AID purchases from July 1972 through March 1976, i.e., fiscal years 1973-1975 and 9 months of FY 1976.

c/ Metric tons of pesticide active ingredient.

Source: AID (20).

Table 17: Pesticides Purchased by AID 1972-1976 in Quantities Over 50 Tons, by Function, Chemical Groups, and Historical Eligibility Status

Insecticides					
Organo-chlorines	Organo-Phosphates	Carbamates	Herbicides	Fungicides	Other Pesticides
b DDT	*a* diazinon	*a* carbaryl	*b* MSMA	*a* mancozeb	*c* ethylene dichloride
a toxaphene	*a* malathion	*b* carbofuran	*a* 2,4-D	*a* maneb	
b BHC	*b* mono-crotophos	*b* methomyl	*a* propanil	*a* zineb	
b endrin	*a* dichlorvos		*a* dalapon-Na		
b heptachlor	*b* methyl parathion				
a chlordane					
	a naled				
	a leptophos				
a - 2 products	*a* - 5 products	*a* - 1 product	*a* - 3 products	*a* - 3 products	*c* - 1 product
b - 4 products	*b* - 2 products	*b* - 2 products	*b* - 1 product		

Note: Table includes all pesticides purchased by AID in quantities over 50 metric tons (110,000 lb) of active ingredient from July 1972 through March 1976. In each column, the pesticides are listed in decreasing order of quantity of active ingredient purchased. Eligibility status (per Historical Commodity Eligibility Listing dated December 16, 1974) symbols: *a* = AID-Approved, *b* = Conditionally Eligible; *c* = Not Listed.

Source: AID (20).

Table 18: Historical Pesticide Procurement Under Commodity Import Program (Private Sector Importers)

Action	Days[a/] Low	High
Application review and approval by Recipient Government Plant Protection Department	20	30
Negotiate with supplier and develop pro forma invoice supply contract	20	40
Application for import license	20	60
Open Letter of Credit in local bank and confirm by U.S. Bank	3	21
Supplier preparation of order, delivery to port, loading on proper vessel	10	60
Ocean transit time	30	50
Discharge, survey, custom clearance, onward transportation	10	60
Processing, packaging, delivery to retail system	20	90
Available to end user	133	411

a/ Time ranges in days required for completion, based on actual experience.

Source: AID (21).

Table 19: Historical Pesticide Procurement by Project Implementation Order for Commodities (PIO/C)

Action	Days[a/] Low	High
Preparation of PIO/C by AID Mission/ Recipient Government (RG)	10	30
PIO/C Worksheet Review, staffing and issuance to Authorized Agent for procurement	7	40
Authorized Agent prepare specifications, prepare and issue solicitation	7	15
Advertise to potential suppliers	20	30
Evaluation of bids and contract awards	7	15
Production time if not shelf item	60	180
Delivery to shipping port, preparation of shipping orders, loading on vessel	20	30
Ocean transit time	30	50
Discharge, survey, customs clearance, onward transportation	10	60
Transport to use area, RG Warehouse, distribution warehouse	10	60
Available to end user	181	510

a/ Time ranges in days required for completion, based on actual experience.

Source: AID (21).

Table 20: Historical Pesticide Procurement by Recipient Government (Formal Invitation for Bids)

Action	Days[a/] Low	High
Preparation of IFB (invitation for bids) by Recipient Government (RG)	20	40
AID review and approval	5	10
Advertise and distribute IFB to trade	45	60
Open bids, review by RG and AID approval, make award to supplier	5	60
Production of pesticide (if not shelf item)	0	120
Delivery to port of shipment and loading on vessel	5	30
Ocean transit time	30	90
Time in RG port waiting time for berth discharge, survey, custom clearance, onward transportation	10	60
Transit time to use area, RG warehouse, distribution warehouse	10	60
Available to end user	130	530

a/ Time ranges in days required for completion, based on actual experience.

Source: AID (21).

Under Commodity Import Programs (Table 18), completion of a transaction required 133 to 411 days. Acquisition of a pesticide via project assistance on project implementation orders (Table 19) required 181 to 510 days, and procurement by the recipient government (Table 20) required 130 to 530 days. One AID Regional Bureau (22) reported that, in its actual experience, procurement and delivery of AID-financed pesticides coincided with application periods about 50% of the time.

These data indicate that in the acquisition of AID-financed pesticides, much planning and foresight of upcoming pest control needs are required. Long time lapses in the overall transaction increase the likelihood of diversion of the pesticide from the originally intended use, and place greater demands on the stability of the pesticide product itself and of the containers in which it is supplied.

AID's historical pesticide procurement procedures did not require pre- or post-use audits in recipient countries. Thus, the Agency does not have complete information on the actual as compared to the intended uses of all the pesticides it has supplied (22). There was no operational mechanism within AID specifically designed to monitor and record information on human health or environmental problems which might arise from AID pesticide activities (23).

Pesticides Financed by AID for Public Health Programs

AID-Financed Insecticides for Antimalaria Programs--

By far the most important use of insecticides in public health vector control programs has been the application of DDT as a residual interior spray against adult mosquitoes to prevent or reduce transmission of malaria. AID and its predecessor agencies have contributed to worldwide malaria control operations since World War II. According to the National Academy of Sciences, United States programs for malaria control administered by the Economic Cooperation Administration (ECA), the Technical Cooperation Administration (TCA), and the International Cooperation Administration (ICA) expended over $60 million between 1945 and 1957 in countries outside the United States (26).

Support for a worldwide malaria eradication program was mandated by Congress in 1957. Between 1957 and 1972, AID expenditures for malaria control programs in the form of loans or grants to 36 less developed countries totaled $531 million. A more detailed analysis of these expenditures is provided in Table 21.

Thus, from the end of World War II up to and including 1972, the United States spent nearly $600 million in support of antimalaria programs in less developed countries.

Insecticides supplied by AID for these antimalaria programs consisted almost entirely of DDT (primarily 75% wettable powder), supplemented by relatively small quantities of two other insecticides, malathion and Abate®. Table 22 presents an analysis of AID-financed purchases of 75% and 100% DDT for antimalaria programs for FY's 1967 to 1975 by country.* During this 9-year period, 15 different countries received a total of 95,136 MT of DDT (100% basis), valued at $49,816,000 (exclusive of freight, insurance, and other shipping costs). About 93% of the total quantity of DDT active ingredient used was supplied as 75% wettable powder.

Between FY 1967 and FY 1975, the DDT quantities (100% basis) purchased by AID for antimalaria programs annually ranged from 133 MT in 1975 to 23,778 tons in 1969. AID's DDT purchases for antimalaria programs declined substantially during this period.

Other direct AID procurements for antimalaria programs included small quantities of other insecticides, sprayers, vehicles, spare parts, antimalaria drugs, and miscellaneous unspecified purchases. Table 23 presents a summary of such purchases for FY's 1967 to 1972. This tabulation shows that insecticides other than DDT (malathion and Abate®) represented only about 0.1% of the value of DDT (25, 75, and 100% concentrations) purchased during the period in question.

The relationship between AID-financed quantities of DDT and worldwide DDT use in antimalaria programs can be assessed with the help of WHO data. Table 24 presents estimated past use and future requirements of DDT for worldwide antimalaria programs, based on data reported in two unpublished WHO working documents.

WHO estimates that at the height of antimalaria spraying operations in the early 1960's, 45,000 MT of DDT (100% equivalent, mostly as 75% wettable powder) were used against malaria annually. Between 1960 and 1963, AID purchases of DDT for antimalaria programs were as shown on page 63.

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* Figures in Table 22 reflect AID's fiscal accounting of funds used to support DDT procurement for antimalaria programs. The figures cannot be considered as a basis for determining quantities shipped or applied in any one year. FY 1975 figures reflect the smaller number and size of orders placed during that period. Data available as of April 1, 1977, indicate that during 1976 orders were placed for DDT equivalent to 2,560 MT of 100% DDT for Indonesia and 870 MT of 100% DDT for Ethiopia for a total commodity value of $4,633,000.

Table 21: AID Expenditures for Bilateral Antimalaria Programs 1957-1972, by Countries

Country	Program Date Start	Program Date End	U.S. Currency Loan	U.S. Currency Grant	U.S.-Owned Local Currency Grant	Total
			$1,000			
Cambodia	1957	1968	--	772	--	772
Indonesia	1957	1967	--	37,643	--	37,643
Laos	1957	1962	--	1,052	99	1,151
Philippines	1957	*a*	--	8,804	--	8,804
Taiwan	1957	1963	--	167	283	450
Thailand	1957	1972	--	18,496	--	18,496
S. Vietnam	1957	*a*	--	8,605	--	8,605
S. Korea	1957	*b*	--	68	--	68
Sri Lanka	1957	1964	--	1,004	599	1,603
India	1957	1972	26,385	83,269	181,970	291,624
Iran	1957	1965	--	4,446	--	4,446
Jordan	1957	1970	--	1,923	--	1,923
Nepal	1957	*a*	--	6,589	8,066	14,655
Pakistan	1962	*a*	23,663	1,286	24,638	49,587
Iraq	1957	1958	--	31	--	31
Afghanistan	1957	*b*	--	44	--	44
Turkey	1957	*b*	--	200	--	200
Ethiopia	1957	*a*	8,388	5,152	--	13,540
Liberia	1957	1965	--	509	--	509
Libya	1957	1965	--	222	--	222
Tunisia	1957	1972	--	534	--	534
Bolivia	1958	1965	--	--	931	931
Brazil	1958	*a*	11,385	14,155	1,696	27,236
Colombia	1958	1964	--	1,762	--	1,762
Ecuador	1957	*a*	2,594	2,162	24	4,780
Guatemala	1962	1969	2,180	2,911	100	5,191
Honduras	1958	1969	2,650	2,497	--	5,147
Jamaica	1958	1965	--	386	--	386
Nicaragua	1966	1972	3,934	2,125	--	6,059
Paraguay	1968	*a*	1,755	272	--	2,027
Costa Rica	1966	*a*	1,451	--	--	1,451
Haiti	1961	*a*	--	17,255	--	17,255
El Salvador	1966	1971	2,665	29	--	2,694
Peru	1960	1965	--	169	--	169
Mexico	1957	1958	--	27	--	27
Panama	1968	1971	1,421	--	--	1,421
			88,471	224,566	218,406	531,433

Notes: *a* Active project as of December 31, 1972.
b Project closed, but ending date not available.

Source: National Academy of Sciences (26).

Table 22: AID-Financed Purchases of 75% and 100% DDT for Antimalaria Programs, FY 1967 - 1975

Country	FY 67	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74	FY 75	TOTAL
					Metric Tons					
Brazil										
75% DDT	7,478	3,338	6,979	4,314	1,159	2,770	5,254	1,759	—	33,051
100% DDT	515	413	242	78	115	87	310	—	—	1,760
Ecuador										
75% DDT	—	—	—	—	—	91	272	344	—	707
Ethiopia										
75% DDT	1,237	1,265	1,746	—	1,633	—	998	1,142	—	8,021
100% DDT	2	13	11	—	—	—	—	19	5	50
Haiti										
75% DDT	—	—	—	—	—	—	—	—	118	118
India										
75% DDT	3,933	9,263	4,608	4,064	5,080	—	—	—	—	26,948
100% DDT	—	—	3,048	767	—	—	—	—	—	3,815
Jordan										
75% DDT	—	47	—	—	—	—	—	—	—	47
Laos										
75% DDT	—	—	—	3	9	—	7	—	52	71
Nepal										
75% DDT	1,421	680	567	518	273	413	274	365	—	4,511
Pakistan										
75% DDT	907	4,500	6,750	5,142	4,487	—	—	—	—	21,786
Philippines										
75% DDT	—	1,449	907	—	125	21	127	—	—	2,629
Sri Lanka										
75% DDT	—	—	2,023	—	—	—	—	—	—	2,023
S. Vietnam										
75% DDT	—	319	163	466	340	136	272	170	—	1,866
Thailand										
75% DDT	4,044	4,943	3,284	2,278	—	—	—	—	—	14,549
Tunisia										
75% DDT	—	326	275	325	71	—	47	—	—	1,044
Indonesia										
75% DDT	—	—	—	—	—	—	245	768	—	1,013
100% DDT	—	—	—	—	—	—	310	410	—	720
TOTAL										
75% DDT	19,020	26,130	27,302	17,110	13,177	3,431	7,496	4,548	170	118,384
=100%	14,266	19,598	20,477	12,833	9,883	2,573	5,622	3,411	128	88,791
100% DDT	517	426	3,301	845	115	87	620	429	5	6,345
TOTAL										
100% DDT	14,783	20,024	23,778	13,678	9,998	2,660	6,242	3,840	133	95,136
$ x 1,000	7,646	10,236	11,490	6,801	5,208	1,470	3,838	2,936	191	49,816

Note: Dollar values do not include shipping costs (freight, insurance, etc.) Figures reflect AID's fiscal accounting of funds used to support DDT procurement for antimalaria programs. The figures cannot be considered as a basis for determining quantities shipped or applied in any one year. FY 1975 figures reflect the smaller number and size of orders placed during that period. Data available as of April 1, 1977, indicate that during 1976 orders were placed for DDT equivalent to 2,560 MT of 100% DDT for Indonesia and 870 MT of 100% DDT for Ethiopia for a total commodity value of $4,633,000.

Table 23: AID Procurements for Antimalaria Programs, FY 1967 through FY 1972

DDT 75% and 100% (including costs of shipping)			$49,879,254
Other pesticides:	25% DDT	$103,412)	
	Malathion	26,591)	160,714
	Abate	30,711)	
Sprayers and Spare Parts			2,096,641
Vehicles and Spare Parts			3,341,441
Drugs			1,325,381
Miscellaneous Unspecified Purchases			2,301,060
TOTAL			$59,104,491

Source: AID.

Table 24: Estimated Past Use and Future Requirements of DDT for World Antimalaria Programs

DDT Form	100%	75% WP	50% WP	25% WP/EC	Total
	------- Metric Tons of 100% DDT ----------				
Early 1960's,) per Year *a*)	NA	NA	NA	NA	45,000
1970 *a*	NA	NA	NA	NA	31,950
1971 *b*	650	33,284	4,250	116	38,300
1972 *c*	669	34,076	3,250	122	38,117
1973 *c*	771	33,285	3,250	164	37,470
1974 *c*	733	33,426	3,250	217	37,626
1975 *c*	704	33,562	3,250	219	37,735
1976 *c*	662	34,880	2,850	223	38,615
1977 *c*	660	38,852	3,150	221	42,883
1978 *c*	648	34,349	3,150	220	38,367
1979 *c*	574	26,703	3,150	170	30,597
1980 *c*	572	26,806	3,150	170	30,698
1981 *c*	497	21,510	3,150	170	25,327
Total 1972 - 81 *c*	6,490	317,449	31,600	1,896	357,435

NA Data not available.

a WHO estimates of actual use.

b Planned requirements for 1971

c Estimates.

based on detailed data from 31 countries in the African Region, 21 countries in the American Region, 7 countries in the South East Asian Region, 3 countries in the European Region, 20 countries in the Eastern Mediterranean Region, and 10 countries in the Western Pacific Region.

Source: Rafatjah (28,29).

FY 1960	26,993 MT
FY 1961	23,449 MT
FY 1962	24,168 MT
FY 1963	27,697 MT
4-Year total	102,307 MT
Average per year	25,577 MT

The 4-year average, 25,577 MT, represents about 57% of the total use of DDT against malaria in the early 1960's, as estimated by WHO.

In FY's 1970 and 1971 (Table 22), AID purchases for antimalaria programs were 13,678 and 9,998 MT of DDT 100%, respectively, equivalent to an annual average of 11,838 MT; that is 37% of the estimated world use of DDT in such programs in CY 1970, 31,950 MT (Table 24). Since 1970, the AID-supplied share of the total quantities of DDT used against malaria worldwide has declined even more rapidly, as a comparison between Table 22 and the WHO estimates in Table 24 indicates.

These reductions of AID assistance to antimalaria programs over the past several years were due to several reasons, including increasingly tight overall AID budgets, assumptions that the worldwide decline of malaria accomplished during the 1960's would continue, and changing program priorities.

The current status of the worldwide antimalaria campaign and AID's role in these efforts are discussed in greater detail in an AID Audit Report entitled "Malaria Eradication Programs," No. 76-348, issued May 7, 1976, included in this document as Appendix F. Readers requiring more specific information on the past history, current status, and future prospects of antimalaria efforts are referred to this document.

United States and World Production of DDT--

Worldwide production capacities and actual production and use of DDT are apparently increasing, while the United States production of this insecticide has decreased substantially since the late 1960's. According to WHO estimates and to Galley (30), the United States production of DDT has declined from 63,000 tons in 1968 to about 30,000 tons/year in the early 1970's. Montrose Chemical Corporation of California has been the only United States producer of DDT for a number of years. The second largest DDT production capacity is in France, at Pechiney Progil/Ugine Kuhlmann, estimated at 20,000 tons/year. Italy, Poland, and the USSR reportedly also have DDT production capacities. Outside the United States and Europe, there are reported to be DDT plants in Argentina, Australia, Bangladesh, Brazil, Egypt, India, Mexico, Pakistan, South Africa, and Turkey. The exact amount of annual production of these plants is not known; all told, it was recently estimated by WHO at more than 20,000 tons of DDT technical per year. Up until 1971 to 1972, Japan also produced DDT, but recent reports indicate that this production has been discontinued.

AID-SPONSORED TRAINING AND TECHNICAL ASSISTANCE ACTIVITIES: THE AID UNIVERSITY OF CALIFORNIA (UC/AID) PEST MANAGEMENT AND RELATED ENVIRONMENTAL PROTECTION PROJECT

Technical assistance and training activities are important elements of AID's pest management assistance to less developed countries. One of AID's delivery systems for this type of assistance is an ongoing project with the University of California initiated in June 1971. The first contract, AID/csd 3296, covered the period July 1, 1971 to December 31, 1974; project expenditures totaled $750,575. Upon termination of this initial contract, a new 3-year contract (AID/ta-C-1195) was approved for the 1975 to 1977 period.

Funding through FY 1974	$595,000
Funding FY 1975	$283,000
Funding FY 1976	$310,000
Projected funding FY 1977-1979	$1,321,000

The project's most recent annual report (31) is included in this EIS as Appendix G.

Objectives

The main purpose of this project is to provide less developed countries with assistance in devising and implementing ecologically and economically sound integrated pest management systems for the control of agricultural pests and diseases in order to facilitate achievement of the long-term goal of increasing their agricultural productivity. The specific objectives of the project, designed to achieve these goals and to complement related AID activities and programs, are as follows:

1. Immediately provide an advisory system to assist AID/W in improved pesticide evaluation, procurement and use.

2. Immediately provide a backstopping resource for AID missions in the area of pest management.

3. Develop and implement on a permanent basis a procedure for backstopping and providing research and technical assistance to AID missions in the evaluation, procurement, and use of pesticides.

4. Assist countries in the development of safeguards and regulatory procedures for the importation, manufacture, formulations, distribution, and use of pesticides.

5. Help countries to develop a national regulatory and pesticide use monitoring system.

6. Aid countries to develop research and training procedures for the development of scientific and technical skills, to develop country-based integrated pest management and environmental protection systems, and to relate the systems to an international cooperative research and technical assistance network.

In carrying out these objectives, the University of California is the lead institution in a university consortium including the University of Florida, Cornell University, North Carolina State University, Oregon State University, and the University of Miami.

Pest Management Advisory Group

In order to bring a broad range of expertise to bear on the project tasks, the University of California under the leadership of the project co-directors, Drs. R. F. Smith, and D. E. Schlegel, formed an advisory group and a panel on pesticides. Initially, the panel was charged with responsibility for carrying out the project tasks related to pesticide management. Subsequently, the panel on pesticides was reconstituted as a part of the parent pest management advisory group.

The advisory group currently has 13 members, including 10 university professors representing the disciplines of entomology, plant pathology, agricultural chemistry, medicine and epidemiology, and three representatives of Federal Government agencies including the U.S. Department of Agriculture and AID. The names, affiliations, and addresses of the current advisory group members are given in Appendix G.

Problem Identification

Identification of those problems having the most serious impact on food production in less developed countries was a major initial task in accomplishing the project objectives. The University of California organized seven multidisciplinary survey teams to make appraisals of food production problems in less developed countries. Six of the seven teams consisted of four to five members each, representing the fields of entomology, plant pathology, nematology, and weed science. Team members were selected from participating departments of the University of California, from other universities, and from the U.S. Department of Agriculture.

These four- or five-member teams visited the following regions and countries:

Southeast Asia:	Philippines	Taiwan
	Thailand	Hong Kong
	Malaysia	Japan
	Singapore	

Mediterranean Basin:	Tunisia Jordan Lebanon	Spain Portugal
Near East Asia:	Turkey Iran	Afghanistan Pakistan
Africa:	Senegal Niger Mali Ghana	Nigeria Kenya Tanzania Ethiopia
South America:	Brazil Uruguay Bolivia	Ecuador Dominican Republic
Central America:	Guatemala Honduras Nicaragua	Costa Rica Panama Guyana

A two-person team visited the following countries:

South and Central America:	Brazil Uruguay Bolivia Peru	Ecuador Colombia Panama Guatemala

All told, the seven study teams covered 32 countries. In the countries assigned, each team identified the most serious pest and disease problems (including environmental deterioration) of important crops, and surveyed crop protection and pesticide handling practices. In each country, team members contacted disciplinary counterparts in the ministry of agriculture, in institutes, and in universities in order to solicit opinions on priority pest problems of major food crops, and to determine the status, effectiveness, and limitations of existing pest management (crop protection) programs.

Each study team prepared a comprehensive report on its findings including the following:

* Analysis of the problems encountered.

* Recommendations for problem priorities, and for programs (research, training, control) to solve these problems.

* Evaluation of the technical capacity or potential of local scientists and facilities.

* Where possible, identification of people who would fit into project training programs.

* Identification of institution building needs.

* Analysis of the way and extent that the University of California/ AID Pest Management Project could contribute to strengthening local capacity to manage these problems.

* Evaluation of social and cultural problems that might arise as a result of problem solutions, and their effects on local agriculture, marketing, and economics.

These team reports represent an invaluable source of information on the pest problems and the pest control-management practices and needs of less developed countries, permitting AID decisions on future pest management assistance to be made on a much sounder basis than would have been possible otherwise. (The detailed findings of each team are summarized in the first part of Appendix G.) All study team reports and their recommendations were thoroughly reviewed by the UC/AID advisory group. Several of the problems identified in the reports, e.g., bacterial wilt and root-knot nematodes, were selected as candidate subjects for development of research programs. An "International Meloidogyne Project" covering research on integrated crop protection systems with emphasis on the root-knot nematodes (Meloidogyne spp.) affecting economic food crops in developing nations was initiated at North Carolina State University in FY 1975. A research project on control of bacterial wilt is currently under consideration (see page 78).

Another problem identification activity early in the program was an international survey on pesticide use conducted by the project's panel on pesticides, acting on a recommendation of the Southeast Asia study team (32). The panel contacted international crop protection experts, soliciting their experiences, opinions and recommendations on problems associated with pesticide use in less developed countries. Nine general questions were sent to 54 organizations and individuals around the world. Twenty-one, or about 40%, replied; 15 of these responded directly to the questions. Countries from which responses were received include India, Sri Lanka, the Philippines, Malaysia, Thailand, Hong Kong, Nigeria, Colombia, and Costa Rica.

Major problems pinpointed by the results of this survey include insufficient stability of pesticides and containers, inappropriate container sizes, and unsafe container disposal practices. Furthermore, respondents reported a complete lack of or gross inadequacy of facilities and equipment, and shortage or lack of technical personnel for the enforcement of pesticide quality standards, and for analysis of pesticide residues in man, food, or environmental samples. Inappropriate pesticide label language and insufficient labeling were also mentioned frequently.

Pesticide Management Seminars and Workshops

One nearly universal finding of the study teams was that programs for the regulation and proper use of pesticidal chemicals are grossly inadequate in nearly all countries visited. Most countries have pesticide registration requirements, but the registration process is either routine or based on very little toxicological, analytical, and performance data. Many pesticide formulations are used in less developed countries based on their clearance in the United States or other developed countries which have quite dissimilar pests and environmental conditions. Often, pesticides are used on the wrong crops for the wrong pest(s) or in wrong amounts. These practices often result in high-level toxic residues on food crops. In most less developed countries, the capacity for monitoring food crops for pesticide residues is very limited or nonexistent. The problem of pesticide residues receives only minimal attention, especially on food crops for domestic consumption. Pesticide residues on agricultural commodities for export are receiving more attention because of possible rejection by recipient countries.

Another serious problem arising from inadequate pesticide regulation in less developed countries is the occurrence of hundreds of cases annually of human pesticide poisonings. Most poisoning cases occur among workers directly involved with the application of pesticides, resulting from improper application equipment, failure to use proper protective clothing, or from mishandling of toxic materials in mixing and filling application equipment. Pesticide accidents also occur from the sale of emptied pesticide containers in local markets and their subsequent use as mixing or storage containers for food and water.

The use of pesticides is increasing in nearly all less developed countries. The problems of toxic pesticide residues and of human poisonings are liable to increase unless the capabilities of less developed countries to regulate the use of pesticides are markedly improved. To assist the less developed countries in this situation, the UC/AID project organized and presented a series of pesticide management seminars and workshops as follows:

* San Salvador, El Salvador, December 3 to 7, 1973

  Subsequent to this workshop, project members supplied consultation and technical advice through various ministries of the Government of El Salvador, and through the pesticide industry. Substantial improvements in pesticide management resulted including, for example, better implementation of regulations on importation of pesticides, and establishment of a more rigorous and acceptable method of quality control for imported materials. In addition, pesticide application methods have been improved, and better coordination on the use of pesticides in integrated pest control, particularly in cotton, have been adopted.

Another improvement that resulted from the seminar workshop and the subsequent consultations was the development of the concept of the green ring, "annilo verde," around cotton fields for the prevention of water contamination and general environmental pollution. This concept has been further reinforced by the routine use of sumps to receive pesticide wastes so they will not enter waterways.

Furthermore, there has been a modification of livestock feeding programs in El Salvador. Prior to the seminar workshop, meat exported from El Salvador was rejected because of high residues of chlorinated hydrocarbon pesticides resulting from livestock feeding on by-products of cotton and corn crops which had been treated with insecticides such as DDT or dieldrin. When the problem was identified through AID consultation, appropriate adjustments in the feeding program were made, and the residue problem was ameliorated.

* Jakarta, Indonesia, July 8 to 13, 1974

This seminar workshop and subsequent consultations, both by team visits and correspondence, encouraged further development of safer programs of pesticide management and improved pest management practices. The first improvement was in pesticide application, by instruction of personnel of the Indonesian Air Force responsible for aerial pesticide applications, resulting in modification of equipment and application practices and reduction in general environmental contamination. Subsequently, the kinds of pesticides and types of formulations used were changed to achieve safer and more effective use of pesticides.

A significant poisoning problem with pentachlorophenol used in the Indonesian lumber industry was analyzed through the assistance of the AID program, and means and steps to first reduce, then eliminate the problem were devised. The AID program was also instrumental in assisting the Indonesians in adopting integrated methods such as drainage and other practices for control of vectors of malaria, dengue fever, etc.

* Manila, The Philippines, February 10 to 15, 1975

This pesticide management seminar workshop was attended by some 325 people representing more than 50 different agencies and approximately 12 different industries in the Philippines. During the seminar, consultation was held with several ministries, particularly those of Agriculture, Health, and the Food and Drug Administration. Private consulting sessions were held with representatives of Fisheries and Wildlife.

Immediately following this seminar, a presidential pesticide decree which had been under development for some months was signed. This decree covers activities from importation of pesticides through use and disposal and empowers the Food and Drug Administration, the Pollution Control Commission, and the Departments of Fisheries and Agriculture to adopt a number of better pesticide use and management practices.

Furthermore, emphasis was given in the seminar to integrated pest management. In the approximately 3 years since it was held, much more effort has been devoted in the Philippines to the development of the necessary techniques. Attention is also being given to the development of protective clothing for pesticide users and improved methods of chemical analysis of pesticides by cooperation of the residue laboratories in the Philippines with a quality assurance program sponsored by the project under subcontract with the University of Miami (see page 113).

* Guatemala City, Guatemala, February 2 to 7, 1976

This seminar workshop could not be completed due to the severe earthquake which occurred in Guatemala on February 4, 1976 and killed an estimated 23,000 people in Guatemala City and surrounding rural areas.

Subsequently, a number of written requests were received both from Guatemala and other Central American countries participating in this seminar workshop, requesting that the interrupted seminar be reorganized, expanded, and completed at the earliest possible date. All of this correspondence indicated a conviction that substantial benefits resulted from the portion of the seminar that was completed and conveyed the feeling that even greater benefits would accrue from a continuation and completion of the seminar workshop.

* Manila, The Philippines, September 1976

The WHO, Western Pacific Office, held the first regional seminar on pesticide management in Manila in September 1976, attended by representatives from some 16 countries and territories. AID provided three speakers for this seminar who collectively were responsible for about 60% of the program. Topics covered included agromedical practices in pest management, integrated pest control, and regulation, chemistry, and disposal of pesticides. Conference attendees were provided with AID pesticide management publications such as the report entitled "The Agromedical Approach to Pesticide Management" (33), the "Pesticide Manual" (34), and a manual for the diagnosis and treatment of pesticide poisoning by paramedical personnel. Requests have since been received for additional information

on pollution control and other aspects of pesticide management. This information is being provided through correspondence. It is anticipated that as a result of this training assistance provided by AID, substantive improvement in pesticide and pest management will occur in these countries.

The University of California project will present additional workshops in the future. Plans are progressing for pesticide management workshops to be held during 1977 in Alexandria, Egypt; Bangkok, Thailand; and Bogota, Colombia (see page 112).

These seminars and workshops promote the "agromedical approach" to pesticide management, as developed by University of California project members. This approach is explained and its elements defined in a UC/AID report entitled "The Agromedical Approach to Pesticide Management" (33). This report is intended for the use of professional workers and administrators in agriculture and health, and for the pesticide industry in less developed countries. It is based on presentations at previous pesticide management seminars and workshops, and includes discussions of the following topics:

* Agromedical approaches to pesticide management.
* World problems of pesticides.
* Integrated pest control and its practical implementation.
* The implication of agricultural insecticides in the development of resistance by mosquitoes.
* Current medical problems of pesticide management.
* Medical aspects of pesticide poisoning, diagnosis, and treatment.
* Chemistry of pesticides.
* Analysis of pesticide residues.
* Chemodynamics.
* Pesticide application.

* Formulations of pesticides for safer, more effective pest control.

* Storage, handling, and disposal of chemicals.

Pesticide Manual

During the first contract period, AID and the University of California sponsored the preparation of a three part, two volume "Pesticide Manual" (34) intended for the use of government officials and others involved in pesticide procurements and in the planning and execution of pesticide programs in less developed countries. The manual provides information on the properties and effects of pesticides, on pesticide quality standards and internationally accepted methods for their enforcement, and on the safe and judicious handling and use of these products. This manual was completed in 1972 and partially revised in 1976; many hundreds of copies have been distributed in all parts of the world.

Special Studies

Responding to requests from AID field personnel and governments of less developed countries, the UC/AID project carried out the following special studies.

Analysis of pesticide handling and use in South Vietnam. This study was performed by a plant pathologist who visited South Vietnam from February 18 to March 2, 1974 (35).

Analysis of pesticide use in Pakistan. The team performing this study included an agricultural engineer, a pesticide specialist, and a medical examiner and pathologist. During 6 weeks in July and August 1974, the team evaluated pesticide handling and use in the field in different parts of Pakistan. The team made recommendations for necessary precautions and safety measures for large-scale use of pesticides in Pakistan, and provided technical advice on symptoms caused by pesticide poisoning and on paramedical treatment, including antidotes (36).

Plant protection in Bangladesh. A study team of five scientists including a plant pathologist, an agricultural economist, a pesticide specialist, and two entomologists evaluated the total crop protection situation in Bangladesh in the period October to November 1975. This team's scope of work included an assessment of the capabilities of the Plant Protection Directorate, and of the capacity of the Government of Bangladesh to undertake plant protection research and training, to plan and implement projects, and to market pesticides (37).

Pest and pesticide management in the Arab Republic of Egypt. During a 7-day mission to Egypt in October 1975, six United States entomologists representing the UC/AID project participated with their Egyptian counterparts in a comprehensive analysis of the cotton pest and pesticide management situation in Egypt (38).

Possible pesticide-fish culture interactions in Colombia. This study was undertaken by Dr. R. F. Smith (entomologist, UC/AID Pest Management Project Director) May 10 to 14, 1976, to provide advice concerning the possible pesticide contamination of fish ponds at an aquaculture research station. This facility is located in a newly established irrigation district in which cotton, tomatoes, plantains, and other crops receiving pesticide applications are raised. The investigator made recommendations for the successful coexistence of the aquaculture station with the irrigated crops (39).

Other Project Activities

In further fulfillment of its objectives, the UC/AID project has, since its inception, encouraged and sponsored attendance at relevant international meetings and conferences by project representatives. One important benefit of such activities is opportunity for liaison and contacts with officials of various international organizations such as FAO, WHO, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), and others who are responsible for planning and implementing programs in less developed countries in the pest management area. A review of meetings attended by project personnel during the period 1974 to 1975 is included in the project's annual report 1975 (Appendix G). That report also includes a summary of overseas activities of project members and consultants during the period 1971 to 1975, covering 62 individual activities, including personnel participating, date, destination, purpose of activity, and date of report submitted.

Sixteen publications have resulted from the project's work from its inception to the end of December 1975. In addition, the project initiated publication of a pest management newsletter in September 1975 (40). This letter is issued periodically; three issues were published through the spring of 1976.

AID-SUPPORTED RESEARCH ACTIVITIES

To further the development and improvement of pest management tools and systems for use in the fields of food (crop and livestock) production and public health, AID has sponsored and supported a variety of research

activities. These programs have been carried out mainly through the following three mechanisms.

1. AID-funded contracts with United States universities and other public agencies, operating within the United States as well as overseas.

2. AID support, within multidonor arrangements, of 13 international agricultural research centers and associated activities.

3. Research components within AID-financed regional or local food production and preservation and public health programs.

AID-supported research activities in categories 1 and 2 are described in this section; those in category 3 are covered in Chapter II, page 103.

AID Research Programs

Pest management-related research programs sponsored by AID basically fall into three categories: human health protection; food production (crop protection) improvement; and animal health protection.

Human Health Protection--

Projects in this area are generally directed toward improved methods of malaria and schistosomiasis control.

Development of a malaria vaccine (University of New Mexico). This project, initiated at the University of Illinois in June 1966 and transferred to the University of New Mexico in the summer of 1972, shows promise of developing a complex-type vaccine to be used against the human blood parasites causing malaria. Indications are that two types of vaccine may have to be developed to attack two different stages in the complicated life cycle of the parasite, i.e., the trophozoite form in the human blood stream and the sporozoite form in the salivary glands of mosquitoes.

Expanded program (six research institutions). In view of the increasing difficulties with presently available malaria control techniques, AID recently expanded its support in the field of malaria immunity and vaccination by providing for a collaborating network of research institutions working on separate aspects of the research necessary in the development of a vaccine for malaria. The institutions are the University of New Mexico, University of Hawaii, Rockefeller University, New York University, Parke-Davis Company, and the Pan American Health Organization.

Funding through FY 1974	$3,184,748
Funding FY 1975	$717,692
Funding FY 1976	$837,000
Projected future funding	$2,079,000

Development of biodegradable DDT analogs (University of Illinois). In this project, DDT analogs have been developed and tested on a small scale which appear to have most or all of the positive attributes of DDT, including persistence on inert surfaces, without its persistence in living systems and its tendency to bioaccumulate and biomagnify in food chains. A number of the insecticide candidates developed in this project have been entered into the WHO scheme for the evaluation and testing of new insecticides, and two are being considered for commercial production.

Funding through FY 1974	$25,000
Funding FY 1975	$55,000
Funding FY 1976	$55,000
Projected future funding	$58,000

Development and testing of environmentally acceptable alternatives for DDT. This project involves field testing at a village level of the less persistent pesticides as residual wall spray for houses, such as malathion and fenitrothion. This project has been funded during FY 1975 through 1977 for a total of $332,000. A 3-year extension of this project is now under consideration.

Environmental effects of pesticides as used in malaria control programs. This proposed project will be an investigation of the ultimate fate and environmental significance (for human health and ecosystem) of DDT, malathion, and other insecticides when used as residual wall spray for malaria control. Initial funding would be $35,000.

Alternative malaria control methods. This project combines sterile insect release techniques with biological control in an attempt to develop usable methods of reducing mosquito populations without relying on pesticides. The project is proposed for 3 years at a funding of $780,000.

In addition, a number of small projects (under $35,000) are being planned on development and testing of new or improved methods of mosquito control.

Self-help malaria program. This proposed program would involve field trials of a number of malaria control techniques, including physical barriers between mosquitoes and the population at risk, water management, antimalaria drugs, larvivorous fish, use of repellent sprays, dry season larvicidal control, and health education. These trials would be conducted on a community basis in Tanzania where self-help is already the officially adopted method of the government and in Nigeria in cooperation with the WHO-Nigerian government cooperative program. This program would be conducted through WHO.

The proposed funding for this 3-year program is $746,000.

Genetic control of Aedes aegypti mosquitoes (University of Notre Dame). This project was designed to establish the technical and economic feasibility of genetic control of Aedes aegypti under East African conditions. This objective turned out to be unattainable within the originally planned 5-year contract, due to a number of technical and administrative problems. However, much valuable baseline information was obtained.

Funding through FY 1974	$812,000
Funding FY 1975	$174,000
Funding FY 1976	$26,000
Projected future funding	None

Improved malaria vector control methods (U.S. Public Health Service). Under a project initiated in 1962 and terminated in 1973, the U.S. Public Health Service, Center for Disease Control, Technical Development Laboratories, Savannah, Georgia, studied problems encountered in many national malaria eradication programs in less developed countries and assisted in improving the efficiency and economy of these operations. Problems addressed included specifications for and testing of pesticides, spray equipment, and pesticide containers; local insecticide formulation procedures; vector population dynamics and resistance; and alternative methods of mosquito control.

Funding through FY 1972 (last year funded) $5,310,794

Schistosomiasis (Tulane University). Schistosomiasis (also known as bilharzia) is a parasitic disease transmitted to man through certain species of snails. This project involved workshops, the preparation of an annotated bibliography, and a state-of-the-art paper on the engineering aspects of schistosomiasis and its control. The principal purpose of this report is to inform health personnel in less developed countries of procedures for control of the disease through changes in the aqueous habitat of the snail vectors.

Funding FY 1972 (only year funded) $27,048

Mosquito control - some perspectives for developing countries (National Academy of Sciences). At the request of AID, an ad hoc advisory panel of the Board on Science and Technology for International Development, Office of the Foreign Secretary, National Academy of Sciences, prepared a comprehensive report describing the benefits, costs, stages of development, and research and development needs with respect to a number of mosquito control methods which are possible alternatives to the use of chemical insecticides (41). Methods covered include breeding source reduction, use of larvivorous fish (fish that eat mosquito larvae), invertebrate predators, genetic control, parasitic nematodes, protozoans and fungi, pathogenic bacteria, insect

growth regulators, and larvicidal plants. This report is designed for non-technical development planners and encourages attention to these alternative approaches to the control of mosquitoes which are being investigated in research programs. All of these methods would potentially reduce reliance on pesticides.

Funding FY 1973 (only year funded) $37,000

New research projects in pest management as related to human health protection include:

Preclinical testing of antischistosomiasis drugs (Johns Hopkins). This project is to evaluate drugs as an alternative to increased reliance on snail control by chemical means. Total projected funding: $254,333.

Preclinical testing of antischistosomiasis drugs (Lowell University). This project is to evaluate drugs as an alternative to increased reliance on snail control by chemical means. Monkeys are to be used as test animals in this study. Total projected funding: $228,189.

Research on molluscicides is under consideration for possible funding beginning in FY 1978; total projected funding: $750,000 to $800,000. No contractor has been selected as yet.

AID is committed to the development of a multidonor consortium type program of research on tropical diseases which will support a multidisciplinary approach to the control of the principal tropical diseases, including alternatives to chemical control of disease vectors. AID intends to give substantial support to this effort.

Food Production (Crop Protection) Improvement--

AID's research programs in this area are aimed primarily at two goals, development of pest-resistant crop plants, and reduction of pre- and post-harvest crop losses due to pests, including weeds and invertebrate pests.

Sorghum pest resistance (Texas A&M University). Sorghum is the fourth most important cereal grain in less developed countries; it is the principal source of cereal food for an estimated 300 million people in these countries. This project, initiated in FY 1974, is designed to improve the genetic resistance of sorghum to major diseases and insect pests.

Funding through FY 1974	$77,290
Funding FY 1975	$78,335
Funding FY 1976	$130,000
Projected future funding (through 1982)	$279,000/year

Disease and insect control in food legumes (University of Puerto Rico). The present production of cowpeas and beans in less developed countries is only about one-fourth of what these crops are capable of yielding with modern

agricultural practices. This project, initiated in 1974, is designed to develop disease- and insect-resistant strains of these legumes to facilitate obtaining higher yields without sharp increases in the use of chemical pesticides. Twelve promising lines of legumes have been isolated. These, with other cultivars showing specific resistance, are being exchanged with breeders throughout the Americas to determine resistance in varying environments, and for crossing with popular local varieties. In a related AID-sponsored project, the University of Puerto Rico, in cooperation with the University of Illinois, is working toward the improvement of the production of soybeans in the tropics through disease and insect control.

Financial data for both of these projects are as follows:

Funding through FY 1974	$500,000
Funding FY 1975	- 0 -
Funding FY 1976	$340,000
Projected future funding	
FY 1977	$100,000
FY 1978	$60,000

In other research projects, AID supports the development of improved varieties of wheat, barley, corn (maize), sorghum, rice, soybeans, and mungbeans. These projects are aimed primarily at improving the nutritional value and the general performance of these crops under tropical conditions.

Pest management--root-knot nematodes (North Carolina State University). Root-knot nematodes diminish yields of a number of major crops in less developed countries, but little is known about the magnitude of these losses, or on how to reduce or avoid them. This project, initiated in FY 1975, is designed to provide essential information in this area.

Funding FY 1975	$240,000
Funding FY 1976	$200,000
Projected future funding	
FY 1977	$210,000
FY 1978	$210,000

New research projects in the agricultural pest management field currently under consideration, for possible initiation in FY 1977, include control of bacterial wilt, and cassava pest management. Prospective contractors or funding levels for these projects have not been established at this time.

Weed control systems in developing countries (Oregon State University). This project, started in FY 1966, was initially focused on adapting advanced weed control technology including the use of chemical herbicides to the needs of less developed countries. In this phase, various cultural practices and commercial and experimental herbicides were tested against dominant weed species under the conditions prevailing in less developed countries.

More recently, the project was redesigned to develop weed control systems for use on small and medium-sized farms in less developed countries growing basic food crops, balancing the use of hand labor, mechanical labor, cultural practices, and herbicides. Special attention has been devoted to systems that avoid displacement of agricultural labor with limited alternative employment opportunities (42,43).

In Northeast Brazil, a project team consisting of two agronomists and an agricultural economist established over 1,800 field plots. Preliminary data indicate that under traditional soil preparation corn and bean yields were reduced 60 to 70% without weed control. Timing of manual weeding was found to be critical. One correctly timed hoeing was superior (as measured by returns over costs) to two manual weedings according to prevalent local practice, and to the use of chemical herbicides.

In field tests in El Salvador, an herbicide-manual weeding combination appeared to be most economical for corn. On rice, herbicide use was consistently the most efficient weed control method. On beans, one manual weeding could be substituted for the recommended rate of herbicide.

Both of the field projects (Brazil and El Salvador) have a dual emphasis, weed control system development and socioeconomic assessment. The project stresses the fact that in many ecological and economic settings in less developed countries, use of herbicides may not be the best solution to weed problems.

Other project activities include training of host country personnel in weed control research methodology and in the practical and safe use of herbicides and other pesticides. Furthermore, the project endeavors to develop and maintain a worldwide communication-information network for weed control, linking institutions and individuals in different developing and developed countries. It publishes an "Infoletter" designed to contribute to this objective (44).

In addition to the weed control systems development project initiated in FY 1966 as described in the preceding paragraphs, a new project entitled "Weed Control Systems Utilization for Representative Farms in Developing Countries," is being initiated.

	Systems Development ($)	Systems Utilization ($)
Funding through FY 1974	2,233,000	0
Funding for FY 1975	340,000	0
Funding for FY 1976	355,000	0
Projected future funding	394,280	1,055,000

Control of rodents. Recognition of the importance of rats in crop production and designation of rats as a most serious pest problem by local agronomists in the Philippines prompted the establishment of the Rodent Research Center on the University of the Philippines campus at Los Banos in 1968 through the combined efforts of TAB-USAID/Manila and the Government of the Philippines. AID procured experts from the Denver Wildlife Research Center, a U.S. Fish and Wildlife Service institute which specializes in vertebrate pest management problems, to conduct research, training, and support programs in the area of vertebrate pest management in accordance with Center goals.

In its relatively brief period of operation, this Center has contributed significant research findings and trained personnel in the area of vertebrate pest management in the Philippines and other Southeast Asian countries. As a result of the improved control methods, farmers have been able to improve crop yields by as much as 50% at a relatively low cost.

The research achievements of the Rodent Research Center include: development of damage assessment methodology in rice and other crops; evaluation of a wide range of toxicants for suitability in Southeast Asia; participation in national surveys of rat damage on rice which provides the Government of the Philippines with an estimate of losses on which to base national control programs; evaluation of traditional control approaches; development and evaluation of alternative damage reduction procedures which have contributed substantially to the current interagency recommendations for nationally coordinated rat control programs in rice fields; overseas training, supported by USAID/Manila, for professional center staff; active participation in a number of scientific conferences and symposia on vertebrate pest management in Southeast Asia; training at the M.S. and Ph.D. level at the University of Philippines at Los Banos for persons in pest management, mostly Center staff; and participatory training (2 to 6 months) in which trainees from other countries engage in ongoing activities of the Center.

Animal Health Protection--

Several AID research programs concern livestock pests, diseases, and disease vectors of major economic significance in less developed countries.

Research on hemoprotozoal diseases (Texas A&M University). Blood parasites as a group constitute the largest livestock disease problem in less developed countries. Many of these diseases debilitate rather than kill animals, resulting in large herds of poorly producing animals which destroy the vegetative cover over vast areas.

This project, initiated in FY 1967, is designed to examine different approaches to controlling livestock blood parasites, including the causative agents of anaplasmosis and babesiosis. Emphasis is on immunization of animals either through vaccines or through "premunization" by a combination of vaccination and chemotherapy. This approach, if successful, would eliminate the need to use insecticides against the disease vectors.

In FY 1975, a related project entitled "Control of Hemoprotozoal Diseases" was initiated.

	Disease Research ($)	Disease Control ($)
Funding through FY 1974	1,723,000	-
Funding FY 1975	281,000	75,000
Funding FY 1976	495,000	75,000
Projected future funding		
FY 1977	395,000	75,000
FY 1978	450,000	0

Sterility methods for tsetse fly control (Agricultural Research Service, U.S. Department of Agriculture). The tsetse fly is the vector of trypanosomiasis, also known as "sleeping sickness" or nagana, a disease affecting large numbers of cattle, as well as humans, in Africa. This project, initiated in FY 1963, is intended to adapt the male sterilization technique for control of the tsetse fly. The technique has largely been developed as such, but has not yet evolved into an effective control program under field conditions. For field use, large numbers of sterilized males must be produced for field release and competition with wild (unsterilized) males in order to break the breeding cycle. If successful, this approach would eventually eliminate the need to use insecticides against tsetse flies. However, in the early stages of field-scale programs, insecticides may be required to reduce native tsetse fly populations to the lowest possible levels prior to release of sterilized males.

Funding through FY 1974	$1,971,000
Funding FY 1975	$419,000
Funding FY 1976	$631,000
Projected future funding	
FY 1977	$420,000
FY 1978	$475,000

Control of vertebrate pests (U.S. Department of the Interior). This project, initiated in FY 1967, is designed to develop methods other than the use of broad-spectrum poisons for the control of noxious vertebrate pests. In less developed countries, the damage to food grain production by rats and birds is very high. The most noxious species of birds and rats are extremely regenerative, causing huge pre- and post-harvest food losses if left uncontrolled.

Weaver birds (*Quelea* sp.), considered to be the most numerous and perhaps the most destructive bird in the world, have plagued small grain farmers throughout Africa for many years. As a part of this project, investigators undertook several field trips to African countries to gather information on bird (and rodent) damage, to evaluate promising damage control techniques, and to develop plans for a regional cooperative research program in East Africa (45).

In one research project on bird control, it was found that special baits, when taken in very small amounts by scouting birds, resulted in alarm signals which frighten bird flocks away from cultivated fields, restricting them to territories not under cultivation.

In another phase of this project, methods for selective, ecologically sound control of vampire bats have been developed (46,47). Vampire bats are the primary vectors of rabies, a major deterrent to livestock production in Latin America. Control procedures to date have been the use of nonselective poisons, or dynamiting the caves in which the vampire bats live along with many other beneficial, insect-eating bats.

In this project, two new techniques specific for vampire bats were developed. Both use diphenadione (diphacinone), an anticoagulant rodenticide that interferes with normal blood clotting. In the first control technique, vampire bats are captured in mist nets placed around corraled livestock and, before release, the bats are treated by smearing their backs with petroleum jelly containing the anticoagulant. When the treated vampire bats then fly back to their colony, they spread the compound to others due to their habits of roosting together in close-knit groups with much physical contact and mutual grooming.

The second control technique takes advantage of the fact that vampire bats are sensitive to lower concentrations of the anticoagulant than are cattle. A low dose of diphenadione is injected into the rumen compartment of cattle from where it is absorbed and circulates in the treated animals' blood stream. Vampire bats taking one normal blood feeding from a treated animal within 2 to 3 days of treatment will receive a lethal dose (48). Both methods are now being rapidly adopted in Latin America.

Funding through FY 1974	$3,170,000
Funding FY 1975	$425,000
Funding FY 1976	$461,000
Projected future funding	
FY 1977	$385,000
FY 1978	$385,000

Physiology and ecology of ticks. Different species of livestock ticks have a major economic importance in many less developed countries, affecting animals directly as well as by transmitting parasitic diseases. A new research project on livestock ticks is currently under consideration. Although no contractor has been selected, $700,000 has been allocated to this project for FY 1978.

AID Support of International Agricultural Research Centers and Associated Activities

Another important mechanism to promote crop and livestock production improvements in less developed countries is AID's support of international agricultural research centers and closely associated activities. In FY 1976, 10 international centers and three related activities received AID support. Twelve centers' activities received AID support through the Consultative Group on International Agricultural Research (CGIAR), an international donor consortium chaired by the World Bank. In addition to the United States, CGIAR includes 16 other countries (Australia, Belgium, Canada, Denmark, France, Federal Republic of Germany, Iran, Japan, Netherlands, New Zealand, Nigeria, Norway, Saudi Arabia, Sweden, Switzerland, and the United Kingdom), and nine international organizations (Ford Foundation, Rockefeller Foundation, Kellogg Foundation, the International Research and Development Center, the World Bank, the Inter-American Development Bank, the Asian Development Bank, the UNDP, and the UNEP). One center, the Asian Vegetable Research and Development Center (AVRDC) at Shanhua, Taiwan, founded in 1971, is not under the CGIAR, but receives support from AID, as well as from other donors including the Republic of China (Taiwan), Thailand, the Philippines, South Korea, Japan, the Asian Development Bank, the Rockefeller Foundation, and several industrial companies.

Most of these international centers have as their primary objective improvements in the production of one or more major agricultural crops or types of livestock indigenous to the area in which each center is located. Pest control or management by the use of chemical pesticides, development of pest-tolerant or pest-resistant crop varieties, or by other methods or combinations of methods usually constitute just one element among many others in the programs and activities of these centers. Thus, AID support of these centers can be credited only partially to pest management. The share of the total effort devoted to pest management activities varies from center to center, with time, depending upon changing priorities.

Brief descriptions of the centers, including their acronyms, full names, locations, starting years, and primary objectives follow, with emphasis on their respective pest management activities, based on their annual reports, as well as on the report by Wade (49). AID support to the centers is summarized below, Tables 25 and 26, pages 89 and 90.

CIAT, Centro Internacional de Agricultura Tropical, Palmira, Colombia. This center, initiated in 1968, is devoted to the agricultural and economic development of the lowland tropics, with special emphasis on Latin America. Research thrusts include production systems for cassava, field beans, corn (maize), rice, beef, and swine. The cassava and bean projects include entomology, plant pathology, and weed control elements. The center is producing beans with yields up to five times the national average. The gain is largely due to cleaning the seed, through which half the important diseases of beans are transmitted.

A weed control research group supports all crop projects.

The livestock projects include animal health components, although the main emphasis in this area is on cattle weight gain improvements by growing different forage crops in place of currently used native grasses (50).

CIMMYT, Centro Internacional de Mejoramiento de Maiz y Trigo, El Batan, near Mexico City, Mexico. CIMMYT, initiated in its present form in 1964, is the prototype international research center; its predecessor had been supported by the Rockefeller Foundation since 1943. CIMMYT became world-famous through the development of high-yielding dwarf wheats by Norman Borlaug. Currently, the center works on corn (maize), wheat, and barley. It has developed its own worldwide network for testing the products of its breeding programs. In 1973 its wheats were grown at 1,140 sites in 66 countries, and its corn varieties at 289 sites in 48 countries.

In CIMMYT's corn program, disease and insect readings are taken at every step of breeding and selection. Susceptibility of kernels to storage insects is also being studied. Testing methods include the mass rearing of two species of stem borers and one species of fall armyworm for deliberate infestation of field trial plots for resistance testing.

In the wheat program, crosses of spring wheat with winter wheat were found to result in new spring wheats with resistance to septoria disease and to rust. Wheat-rye crosses known as triticale were not susceptible to the same diseases as wheat, but diseases not common on wheat have been identified on some triticale lines. Of 169 triticale lines tested, 126 lines were resistant to three races of Hessian fly (*Mayetiola destructor*), an important pest of cereals in many countries.

In the barley breeding program initiated in 1972, development of disease resistance is receiving high priority because staggering numbers of diseases attack barley. Sources of resistance to many barley diseases have been found under Mexican conditions, but screening at numerous sites around the world is necessary to determine resistance genes (51).

CIP International Potato Center, Lima Peru. This center, initiated in 1972, focuses on the development and dissemination of knowledge for the greater utilization of the potato as a basic food. Of nine current major research objectives, five are in pest management: (a) control of selected fungal pathogens including *Phytophthora* sp., *Synchytrium endobioticum*, *Spongospora subterranea*, *Choanephora* sp., *Sclerotium rolfsii*, and *Fusarium* sp.; (b) control of selected bacterial diseases including *Pseudomonas solanacearum* and *Erwinia carotovora*; (c) control of selected virus and insect vectors; (d) control of selected nematode pests including *Heterodera* sp., *Meloidogyne* sp., *Pratylenchus* sp., and *Nacobbus* sp.; and (e) development of potatoes with wider adaptation to environmental stress and resistance to insects. In keeping with these objectives, the center's staff includes nematology and plant pathology departments, but appears not to emphasize entomology. Control of the pest and disease organisms enumerated is sought primarily through genetic resistance (52,53).

ICRISAT, International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India. This institute, initiated in 1972, serves as the world center for improvement of the genetic potential for grain yield and nutritional quality of sorghum, pearl millet, pigeonpeas, chickpeas, and peanuts (ground nuts). Another objective is the development of farming systems which will help to increase and stabilize agricultural production through better use of natural and human resources in the seasonally dry semiarid tropics. The potential beneficiaries of this work are the 400 million inhabitants of the semiarid tropics, primarily in Asia and Africa.

The center's staff includes two entomologists and one plant pathologist. Current pest management-oriented work includes identification of insects and diseases reducing yields of sorghum, pearl millet, chickpeas, and pigeonpeas. Several insect pests causing major crop damage were identified, and screening for resistance as well as trials with chemical pesticides were initiated (54). The institute's annual reports for 1974 to 1975 and 1975 to 1976 are not available (55).

IITA, International Institute of Tropical Agriculture, Ibadan, Nigeria. This center, initiated in 1965, has four major research programs: (a) farming systems for lowland tropics; (b) cereals improvement (corn and rice), (c) grain legumes improvement (cowpeas, soybeans, lima beans, pigeonpeas), and (d) root and tuber crop improvement (cassava, sweetpotatoes, yams). The programs focus on the lowland tropics, with special emphasis on Africa. The institute's operations were virtually suspended during the Nigeria civil war, but were resumed after it ended.

Of the four major programs, work on the improvement of grain legumes, particularly cowpeas, has been most successful thus far. From its germ plasm collection, IITA produced cowpea crosses that yield up to one-third more than the best local varieties. Resistance to a number of diseases has been combined into single lines which require pesticide applications only twice instead of 10 times a season.

In the root and tuber crop program, a search is under way for sweetpotatoes resistant to weevils. Work on most or all of the other crops covered includes identification of economically important pests, and studies on the control of insect pests and diseases by chemical pesticides, resistance breeding, and other methods.

In a special joint project with the British Centre for Overseas Pest Research (COPR), the fate and distribution of DDT and its major breakdown product, DDE, in the cowpea crop ecosystem are being studied. A flow chart showing gross pesticide movement between the various environmental compartments was developed, based on preliminary analytical data (56).

IRRI, International Rice Research Institute, Los Banos, Philippines. This center, initiated in 1959, works on the improvement of irrigated rice, upland rice, and multiple cropping systems, covering rice problems worldwide, with special emphasis on Asia. Within a few years of its founding, IRRI came through with high-yielding strains of rice which became famous in the early stages of the so-called green revolution. Since IRRI's first high-yielding variety, IR-8, was released in 1966, rice yields were not significantly further improved, but major progress was made in resistance improvement. For instance, one of IRRI's recent lines, IR-2061, is at least moderately resistant to six or seven major insect and disease pests.

In the institute's current program, control and management of diseases, insects, and weeds by genetic, biological, chemical, cultural, and integrated methods receive major emphasis. Rice diseases under study include blast (*Pyricularia oryzae*), sheath blight (*Corticium* spp.), bacterial blight (*Xanthomonas oryzae*), and virus diseases including tungro and its insect vectors. Different insecticides, application methods, and other procedures for the control of rice insects are being studied. Weed control experiments with a number of commercial and experimental herbicides are being conducted at the IRRI farm, at three research stations of the Philippines Bureau of Plant Industry, and in farmers' fields.

The agricultural engineering department works on the development of simple farm machinery suitable for manufacture in less developed countries. A deep-placement, four-row liquid chemical applicator with a peristaltic liquid metering pump was designed which will permit substantial savings in the use of pesticides (and fertilizers) through deeper placement in puddled soils. Another development is a manually operated, single-row, push-type applicator which will deposit granular material at a 10-cm depth in puddled soils (57).

ILCA, International Livestock Centre for Africa, Addis Ababa, Ethiopia. The purpose of this center, established in 1974, is to increase production of tropical Africa's 130 million cattle, 100 million sheep, and 80 million goats. The center's research programs are still in the formative stage, and its facilities and staffing are not expected to be completed before 1978. Studies on trypanosomiasis (sleeping sickness) and on the control of the disease vector, the tsetse fly, are included among the center's planned activities (58).

ILRAD, International Laboratory for Research on Animal Diseases, Nairobi, Kenya. This center, initiated in 1974, is concerned primarily with two major diseases of livestock, trypanosomiasis and theileriasis. Trypanosomiasis is prevalent in vast stretches of land south of the Sahara which could otherwise support an estimated 200 million cattle. Theileriasis, a major form of which is known as East Coast Fever, is another blood-borne parasitic disease, spread by the tick, *Rhipicephalus appendiculatus*. With both parasites, ILRAD research programs have a strong immunologic orientation. At present, ILRAD is still in the process of putting up its buildings and physical facilities which are to be completed in 1978 (59).

IBPGR, International Board for Plant Genetic Resources, Food and Agriculture Organization of the United Nations, Rome, Italy. The purpose of this board, established in 1973, is the conservation of plant genetic material, with special emphasis on cereals. The Board which currently has 13 scientists as members, will encourage the development of seed collections, support existing collection programs, and recommend the establishment of new collections where necessary. Furthermore, it will create an international documentation system which will allow breeders anywhere in the world to determine if the germ plasm they need is available (60).

WARDA, West African Rice Development Association, Monrovia, Liberia. This organization, initiated in 1971, is a regional cooperative effort of 13 West African nations. WARDA was established to conduct adaptive rice research with the aim of raising production and reaching self-sufficiency. It does not attempt to develop new rice varieties itself, but receives support from IRRI and IITA. WARDA conducts coordinated trials of rice varieties as affected by fertilizers and crop protection methods at a network of locations in West Africa. It emphasizes use and adaptation of existing knowledge and experience. It provides direct support to national research programs and linkages with international research centers.

Research on insect pests, diseases and weeds is integrated into variety improvement projects at Mopti, Mali (deepwater and floating rice); Rokupr, Sierra Leone (mangrove swamp rice) and Richard Toll, Senegal (irrigated rice). WARDA-coordinated trials in 1974 included 12 herbicide trials in 9 different countries and 8 insecticide trials in 8 different countries (61).

ICARDA, International Center for Agricultural Research in Dry Areas, Lebanon. This center was authorized in 1975; its first two research stations will be in Iran and Syria, respectively. The center is to work on crop and mixed farming systems with a focus on sheep, barley, wheat, and lentils, and will emphasize the development and improvement of such farming systems for the semiarid winter rainfall zones. Specific projects and approaches are still in the formative stage.

CARIS, Current Agricultural Research Information Service, FAO, Rome, Italy. This activity was initiated in 1975.

AVRDC, Asian Vegetable Research and Development Center, Shanhua, Tainan, Taiwan. This center is supported principally by six countries, including the Republic of China (Taiwan), the United States, Thailand, the Philippines, South Korea, and Japan. In addition, the Asian Development Bank and several industrial corporations operating in the Far East provided grants, and the Rockefeller Foundation furnished the services of the Center's director and a grant of $25,000 (1974). AVRDC is not a member of the CGIAR-sponsored international network of agricultural research centers but would probably join the network if a satisfactory political formula could be worked out (62).

The Center's program includes studies on the major arthropod pests of leguminous plants and methods for their control, including chemical insecticides and development of resistant varieties.

AID has supported AVRDC since 1971 at a level of $600,000/year.

Table 25 presents a summary of AID contributions to the CGIAR-supported international agricultural research centers (not including the Asian Vegetable Research and Development Center in Taiwan) during the 8-year period 1969 to 1976. Total AID support to these centers increased from $425,000 in 1969 to $15.1 million in 1976. Over the 8-year period covered, AID support totaled $46.7 million, or 20.7% of the total support received by the centers from the international donor consortium represented by CGIAR.

Table 26 summarizes total CGIAR allocations to the international research centers for the years 1973 to 1976, broken down by individual centers and years. Total allocations to all centers increased from $25.7 million in 1973 to $64.6 million in 1976. Each of the eight centers which were in operation in 1973 received substantial increases in their respective allocations between 1973 and 1976, and four additional centers were initiated in 1974 and 1975. No additional centers are planned for the time being.

Table 25: AID Contributions to Consultative Group on International Agricultural Research (CGIAR)-Supported International Agricultural Research Centers

	AID	Other Donors[a/]	Total	AID Share of Total
	----------	$1,000	----------	
1969	425	9,664	10,089	4.2%
1970	1,679	8,763	10,442	16.1%
1971	2,984	11,900	14,884	20.0%
1972	3,507	16,290	19,797	17.7%
1973	5,385	20,315	25,700	21.0%
1974	7,000	26,775	33,775	20.7%
1975	10,655	36,182	46,837	22.7%
1976	15,100	49,485	64,585	23.4%
1969-1976	46,735	179,374	226,109	20.7%

a/ Other donors include: Nine organizations (Ford, Rockefeller and Kellogg Foundations; International Research and Development Center; World Bank; UNDP; UNEP; and the Inter-American and Asian Development Banks); and 16 countries (Australia, Belgium, Canada, Denmark, France, Federal Republic of Germany, Iran, Japan, Netherlands, New Zealand, Nigeria, Norway, Saudi Arabia, Sweden, Switzerland, and the United Kingdom).

Source: AID

Table 26: Consultative Group on International Agricultural Research (CGIAR) Allocations of Funds to International Agricultural Research Centers, 1973-1976

Center[a]	1973	1974	1975	1976[b]
	$1,000			
CIAT	4,215	3,845	6,005	7,300
CIMMYT	5,435	4,505	7,415	9,800
CIP	1,380	1,960	2,600	4,100
ICRISAT	3,465	6,175	8,070	8,400
IITA	5,535	5,345	8,156	10,000
IRRI	2,890	3,740	8,601	8,900
ILCA	245	1,070	1,960	4,900
ILRAD	465	1,640	2,265	4,800
IBPGR		335	555	1,000
WARDA			555	800
ICARDA			375	3,300
CARIS			280	600
Unallocated	2,070	5,160	-0-	685
Total	25,700	33,775	46,837	64,585

a/ See text for explanation of the acronyms for the centers.
Sources: CGIAR, AID
b/ As of July 1976; figures rounded.

In their annual reports and financial reports, none of the centers shows resources allocated to pest management-related activities segregated from other program elements. To obtain information on the percentage of AID support to the centers that might be assigned to pest management, an estimate of the share of pest management-related activities in relation to all activities for the period 1974 to 1976 was made for the 12 CGIAR-supported centers. These estimates, based on each center's staffing and/or research programs and priorities as documented in their annual report and/or their forecasts for 1976, are presented in Table 27. The unweighted average for all centers was found to be about 28%. Applying this factor to AID's total support to these centers for the years 1974, 1975, and 1976 (Table 25) yields the following results:

	AID Support	
Year	Total ($)	Pest Management-Related ($)
1974	7,000,000	1,960,000
1975	10,655,000	2,983,400
1976	15,100,000	4,228,000

The Asian Vegetable Research and Development Center (AVRDC), Taiwan, is not included in these estimates. Its report indicates that about 30% of its activities are related to pest management. Since AID contributes $600,000/year for this Center, $180,000/year is attributable to pest management.

These estimates are offered as best available approximations in order to provide an indication of the order of magnitude of AID's contributions to pest management improvements in less developed countries via its support of the 13 international centers and associated activities discussed in this section.

Coordination of Research

Some of the current or planned research projects bilaterally supported by AID potentially have the same or very similar objectives as research work supported multilaterally by international organizations or by other national donors. For example:

In the human health protection area, the British Centre for Overseas Pest Research (COPR) conducts extensive research on schistosomiasis, with major emphasis on the development of better molluscicides. The COPR project includes a free confidential service of screening candidate molluscicides against the snail *Biomphalaria glabrata*; synthesis of radiolabeled

Table 27: Estimated Share of Pest Management-Related Activities in Total Programs of Consultative Group on International Agricultural Research (CGIAR)-Supported International Agricultural Research Centers and Related Activities, 1974-1976

Center Activity[a]	Pest Management Share in Total Program[b]
CIAT	15-20%
CIMMYT	8-10%
CIP	40-50%
ICRISAT	15-20%
IITA	25-30%
IRRI	25-30%
ILCA	10-15%
ILRAD	90-100%
IBPGR	10-20%
WARDA	40-50%
ICARDA	10-15%
CARIS	10-20%
All centers activities, unweighted average	28%

a/ See text or Glossary for explanation of the acronyms for the centers activities.

b/ RvR Consultants estimates, based on each organization's staffing and/or research programs and priorities.

Sources: References 49 through 62; RvR Consultants estimates.

molluscicides for distribution and mode of action studies; and studies on the short- and long-term effects of molluscicides on tropical fish. In addition, COPR is carrying out field work in Ethiopia, including epidemiological studies; a 5-year pilot snail control project in Adwa, Tigre Province; and surveys and planning work for control projects in the Awash Valley, around Lake Zarai in the Rift Valley, and at other locations (24).

In the area of food production (crop protection) improvement, AID's research programs aimed at the development of insect and disease resistance in crop plants including sorghum and food legumes potentially overlap the efforts of several of the international agricultural centers which receive substantial AID support through multidonor arrangements.

In the field of animal health protection, WHO and FAO, with support from the United Nations Development Programme, are developing programs for the control of trypanosomiasis and of its vector, the tsetse fly. A preliminary 5-year research and development project was outlined at the FAO Expert Consultancy on Trypanosomiasis and Tsetse Control in Rome in October 1974 (24).

The International Livestock Center for Africa (ILCA) in Addis Ababa, Ethiopia, and the International Laboratory for Research on Animal Diseases (ILRAD) in Nairobi, Kenya, both plan to work on trypanosomiasis and on tsetse fly control, as well as on tick-borne livestock diseases (page 87).

Control of noxious birds, especially weaver birds (Quelea sp.) in central and southern Africa, is the objective of several projects supported by FAO, the United Kingdom, the Federal Republic of Germany, and others (24,25).

There has been no operational mechanism within AID specifically designed to coordinate bilaterally supported AID research projects with research activities supported by other donors.

OTHER ACTIVITIES

All of the pest management activities discussed in the preceding sections of this chapter, i.e., pesticide activities, training and technical assistance, and research are important components of pest management programs. However, the ultimate objectives of increasing food production and the health of man through improved crop protection, increased agricultural productivity, and abatement of vector-borne diseases can be accomplished only if and when these individual components are combined into successful action programs.

The reports by the multidisciplinary study teams who surveyed crop protection and pesticide problems in less developed countries under the AID/University of California Pest Management and Related Environmental Protection Project indicate that many less developed countries currently do not have adequate in-country infrastructures* for the development and operation of pest and pesticide management programs in which all necessary individual components are properly integrated and implemented. In many countries, know-how, qualified personnel, facilities, equipment, etc., are lacking. More specifically, these needs include some or all of the following:

* Establishment and implementation of national (less developed country) pesticide laws and regulations, covering -

  Pesticide registration and labeling,
  Pesticide quality and performance standards,
  Pesticide residue tolerances,
  Pesticide applicator training and qualifications, and
  Enforcement;

* Pesticide residue monitoring (facilities, equipment, and trained personnel), covering -

  Humans,
  Food (for export, for domestic consumption), and
  Environmental (water, air, soil, and nontarget biota);

* Development of in-country capabilities in the establishment and operation of integrated pest and pesticide management systems meeting short-term and long-term local needs. including -

  Administration and supervision,
  Extension,
  Teaching and training,
  Research (emphasizing adaptive research), and
  Pesticide handling (formulating, repackaging, labeling, warehousing, transportation, distribution, application, and container disposal).

To date, assistance to less developed countries in the establishment and operation of such pest and pesticide management infrastructures has not been a major objective of AID's pest management program. Efforts of international organizations including FAO, WHO, and the joint FAO/WHO Food Standards Programme (Codex Alimentarius Commission) to assist less developed

* Infrastructure is defined in this context as "the essential elements of a system or plan of operations."

countries in these areas have not received concerted support from AID or other U.S. government agencies. However, activities in this area will receive greater emphasis in future AID programs as outlined in greater detail in Chapter VI of this document (see page 333).

RELATIONSHIP BETWEEN PROGRAM ELEMENTS

Table 28 presents a summary of AID's current (FY 1975 to 1976) and anticipated (FY 1977 to 1978) expenditures for pest management programs, broken down by pesticide activities, training and technical assistance, research, and other activities. Pesticide and pest management activities which are minor components of local or regional development projects aimed at general rural development or improvement of crop or livestock production systems are not included in this tabulation because complete quantitative data are not available on the magnitude of pest management-related expenditures within such projects.

Table 28 shows that pesticide activities received about the same level of support (both in terms of dollars spent and percentage of total expenditures for all pest management activities) in FY 1976 as in FY 1975. (In making this comparison, it must be noted that FY 1976 figures include the transitional quarter for the change in the U.S. federal fiscal year and thus cover 15 months.) In both years, there was very modest support for training and technical assistance activities; substantial support for research activities; and no specific support for other activities such as development of pest and pesticide management infrastructures in less developed countries.

Table 28: AID Expenditures for Pest Management Programs,[a] FY 1975-FY 1978

Program Elements	FY 1975	FY 1976	FY 1977	FY 1978
	$1,000			
Pesticide Activities				
Food Production[b]	10,793	1,129[c]	810	N.A.
Public Health	191	12,885[c]	28,600	N.A.
Subtotal	10,984	14,014[c]	29,410	N.A.
Training and Tech. Assistance Activities (Univ. of Calif.)	283	310	1,321 for 1977-79	
Research Activities				
AID Research Programs				
Human Health	947	918	N.A.	N.A.
Food Production	658	1,025	~ 1,000	N.A.
Animal Health	1,200	1,662	1,275	2,010
Internat'l. Ag. Res. Centers[d]	3,163	4,228	N.A.	N.A.
Subtotal	5,968	7,833	N.A.	N.A.
Other Activities	N.A.	N.A.	N.A.	N.A
Total	17,235	22,157	N.A.	N.A.

a/ Based on actual historical data and currently identified pest management activities Data do not include pesticide or pest management activities where these are minor elements in local or regional rural development or crop or livestock production improvement projects.

b/ Includes CIP for FY 1975 through FY 1977.

c/ FY 1976 includes the transitional quarter for the change in fiscal year. The FY 197 data, therefore, are for 15 months.

d/ Estimates based on unweighted average pest management activity of 28% for all AID-supported research centers.

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CHAPTER II

CURRENTLY IDENTIFIED AID PEST MANAGEMENT PROGRAMS

AID plans to continue to provide pest management assistance to less developed countries, within the large framework of the Agency's continuing efforts to assist these countries in alleviating the basic problems of hunger, malnutrition, disease, and poverty.

The discussion of AID's current and anticipated (through CY 1978) pest management activities in this chapter is organized into 8 sections. The first section outlines the general nature and scope of the anticipated programs. The second section, dealing with policies, guidelines and regulations, describes two new, recently established regulations which affect AID's pest management activities. The third section discusses currently identified pest management activities in terms of the four major pest management program elements, i.e., pesticide activities, training and technical assistance, research, and other pest management activities. The fourth section discusses the historical background and current setting of the public health and food production situation in less developed countries. The next three sections present currently identified regional pest management activities in the program areas of food production and preservation, public health, and other programs, respectively. The final section in this chapter contains the references.

NATURE AND SCOPE

To date, AID's pest management activities have consisted primarily of three program elements: pesticide activities; training and technical assistance; and research. In Chapter I of this document, these activities were reviewed through FY 1975. In addition, the section "pesticides financed by AID for food production purposes" (page 48) and Appendix B include data on AID-financed pesticides by individual active ingredients and quantities through March 1976. For training, technical assistance, and research projects initiated in or prior to FY 1975, information on funding for FY 1976 and projected future funding is included where applicable in sections of Chapter I.

AID's pesticide activities, pest management related training and technical assistance, and research activities are expected to continue. Specific activities have been identified through CY 1978. Information on currently identified activities in these three program elements is summarized in subsequent sections of this chapter.

Regional AID programs which contain pest management components include both current and projected bilateral and multilateral development assistance through loans or grants, technical advisory services, research, and training. A few of these diverse programs deal primarily or exclusively with pest management. In most instances, however, pest management is only one of many subcomponents of programs aimed at general rural and agricultural development, improvement of public health, farm technology, cropping systems, etc. Pest management activities within such programs are integrated with other activities as required to accomplish the overall program objectives.

Information on currently identified (through CY 1978) regional programs containing pest management elements is presented on pages 128 through 200 and summarized in Tables 31 to 41. Food production and preservation programs are discussed first, followed by public health programs and other pest management programs.

POLICIES, GUIDELINES, AND REGULATIONS

The historical policies, guidelines, and regulations that governed AID's pest management program before 1976 were discussed in Chapter I (see page 9). Recently, two important new regulations affecting the Agency's pest management activities have become effective: (a) the "AID environmental procedures (Regulation 16)," and (b) the interim regulations on provisions of assistance for procurement and use of pesticides. These two regulations, contained in Appendices C and D, respectively, are reviewed in this section.

Both of these regulations were developed and promulgated in accordance with a Stipulation and Court Order dated December 5, 1975, (1) issued by the U.S. District Federal Court for the District of Columbia (see Appendix E). This stipulation disposed of a suit brought against AID in April 1975 by the Environmental Defense Fund, Inc., the National Audubon Society, the Natural Resources Defense Council, Inc., and the Sierra Club.

AID Environmental Procedures (Regulation 16)

Proposed environmental procedures (2) dated March 24, 1976, were published by the AID Administrator in the Federal Register of March 29, 1976. Following receipt of comments on the proposed procedures, the final procedures (3) along with AID's responses to the comments were published in the Federal Register of June 30, 1976, and became effective immediately upon publication.

These "Environmental Procedures," also referred to as "Regulation 16," amend Title 22 of the Code of Federal Regulations by adding a new Part 216. This addition is intended to assist AID in implementing the requirements of

the National Environmental Policy Act of 1969 (NEPA). The new procedures were developed to ensure that environmental factors and values are integrated into the decision-making process of AID, and to assign responsibilities within the Agency for assessing the environmental effects of its actions. The regulation states that it is AID policy:

> "To ensure that the environmental consequences of proposed AID-financed activities are identified and considered by AID and the host country prior to a final decision to proceed, and that appropriate environmental safeguards are adopted;
>
> "To assist in strengthening the indigenous capabilities of developing countries to appreciate and evaluate the potential environmental effects of proposed development strategies and projects, and to select, implement and manage effective environmental protection measures; and
>
> "To identify impacts resulting from its actions upon the environment including those elements of the world biosphere which are the common natural and cultural heritage of mankind."

The Regulation covers the following areas:

* It defines important elements of the environmental procedures, including the Council on Environmental Quality (CEQ) guidelines, initial environmental examination, threshold decision, environmental assessment, environmental impact statement, negative determination, and negative declaration. Also defined are several internal AID documents, including Project Identification Document (PID), Program Assistance Initial Proposal (PAIP), Project Review Paper (PRP), Program Assistance Review Document (PARD), Project Paper (PP), and Program Assistance Approval Document (PAAD).

* It describes AID activities which may not be "major Federal actions significantly affecting the human environment" and will, therefore, not normally require the filing of an environmental impact statement or the preparation of an environmental assessment. Examples given include certain research; education or training activities, projects in which AID is a minor donor to a multidonor project without potential effects on the environment of the United States or areas outside any nation's jurisdiction; United States institution-building grants; and disaster and emergency relief activities.

* It identifies types of AID actions which may be "major Federal actions significantly affecting the quality of the human environment" and will, therefore, require evaluation under the environmental procedures. "Significant effects" to be considered include "those which adversely affect such aspects of the human environment as air, water,

land, flora and fauna, and socioeconomic conditions." Special attention should be given to problems involving, among other things, hazardous substances.

* It sets forth general and detailed procedures for the initial environmental examination, threshold decision, preparation of environmental assessment or environmental impact statement, intraagency processing and review, monitoring of environmental impact during implementation of projects or programs, and revisions of previous assessments when new facts or information become available.

* It assigns responsibilities within AID for carrying out the environmental procedures.

Pesticides or pest management activities are not specifically mentioned in any part of the "Environmental Procedures," but are clearly included by definition in the AID activities to be considered under this regulation.

Interim Regulations on Provisions of Assistance for Procurement and Use of Pesticides

Pursuant to Clause 7 of the above mentioned Court Order and Stipulation (1), AID adopted interim regulations on assistance for the procurement and use of pesticides. These interim regulations were sent to all affected U.S. Embassies, and Department of State and AID Officials and Missions by telegram on January 18, 1976 (4) becoming effective immediately. The interim regulations are as follows.

AID will not provide assistance for the procurement and use of DDT (except for public health use); aldrin and dieldrin (except for restricted termite use, the dipping of roots and tops of nonfood plants); 2,4,5-T; chlordane; and heptachlor.

AID will not provide assistance for the procurement or use of a pesticide which is not registered, for a use which is not registered, for a pesticide or a use which has been finally suspended, or for a use or pesticide which has been cancelled by the U.S. Environmental Protection Agency (EPA). Furthermore, AID will not provide assistance for a use or a pesticide for which EPA has given notice of intent to suspend after 60 days from such notice, except that such assistance may be provided if the Administrator personally determines, in writing, that the benefits of using the pesticide outweigh the potential adverse effects and that no preferable alternative is available.

The above prohibitions do not apply to assistance for pesticides if the responsible AID employee determines, in writing, that the pesticide will be used for health purposes (either human or animal), and that significant health problems will occur without the use of the pesticide.

AID may provide assistance for the use of any pesticide referred to above if the AID administrator personally determines, in writing, in each specific instance, that an emergency exists. An emergency will be determined to exist when a pest outbreak has occurred or is about to occur, and no pesticide registered for the particular use or alternative method of control is available to eradicate or control the pest, and when significant economic problems will occur without the use of the pesticide.

Notwithstanding the above, AID may provide assistance for the procurement and use of a pesticide even though the pesticide is not registered in the United States (or has been cancelled at the end of a 5-year registration period or at the request of a registrant), if the pesticide will be used on agricultural crops and associated vectors not grown or found in the United States, and if the AID Administrator personally determines, in writing, that the benefits of using the pesticide outweigh the potential adverse effects and that no preferable alternative is available.

Any determination by the AID Administrator as mentioned in the preceding paragraphs will be made in consultation with EPA, will include a statement of the basis for the determination, and will be published in the Federal Register within 10 days of the time the determination is made. AID will, unless time constraints do not permit, provide public notice that the Administrator intends to render such a determination. A determination made by the Administrator when time constraints do not permit issuance of a public notice of intent will, nevertheless, be made in consultation with EPA and will include a statement of the basis for the determination.

These prohibitions do not apply to assistance provided by AID for controlled experimentation of limited scope that does not involve direct application for crop production purposes.

These interim regulations superseded Part II.C--"Pesticides" of the AID Commodity Eligibility Listing.

The Department of State telegram transmitting these interim regulations also provides AID Missions and field personnel with instructions for implementation and contacts for further information and guidance as needed.

As required by these interim regulations, AID/W established cooperation with EPA, providing especially for up-to-date information on the United States registration status of pesticides under consideration for financing by AID, and for use in AID-assisted programs in less developed countries (5-7).

The implementation and administration of these interim regulations have proven to be difficult in practice because many pesticide and pest control needs in the less developed countries are not covered (or are not adequately covered) by United States domestic pesticide regulations, label recommendations, and residue tolerances. The stipulated requirements of personal involvement of the AID Administrator in each request for a pesticide specifically restricted by the interim regulations, and of Federal Register publication of each such action, have had the effect of stopping all requests for such restricted pesticides. The complete procedure has never been invoked since the effective date of the interim regulations. This does not mean, however, that the use of United States-restricted pesticides in less developed countries has been affected accordingly; dieldrin, chlordane, heptachlor, and other United States-restricted pesticides continue to be available to these countries from other donors and sources of supply (8). Thus, the net result of the application of domestic United States pesticide regulations and restrictions to AID's activities in less developed countries may not be the use of environmentally more benign pesticides, but a switch to other sources of supply of United States-restricted pesticides. If AID withdraws from such projects, then the Agency also foregoes the opportunity to assist less developed countries in avoiding unintended and adverse effects of the pesticides concerned.

After more than 4 months' cooperation with AID in implementing the interim regulations and supplying AID with information on the United States registration status of pesticides, EPA, in a letter to AID (7), identified the following four major problem areas in the operation of these procedures:

* Pests not native to the United States, e.g., tsetse fly, desert locust.

* Use site not native to the United States, e.g., tropical rain forests.

* Pesticide manufactured by an American corporation only for export.

* Pesticide products marketed under different trade names in different countries, or in different formulations under the same trade names.

In the same letter, EPA pointed out that Mr. Russell Train, the EPA Administrator, in his testimony before the Senate Foreign Relations Committee on May 5, 1976, noted that realistic economic development assistance by the United States should encourage developing nations to incorporate sound environmental planning as an integral part of new industrial systems.

EPA also said that it believes such an approach would go a long way in helping to develop effective partnerships for dealing with the critical global environmental problems which humanity faces today. EPA stated that it was encouraged by AID-sponsored programs for sending multidisciplinary teams of experts to less developed countries to assist in the training, design, and operation of more efficient and safe indigenous pest management programs (see Chapter I, page 65, and Chapter II, page 112). EPA would hope to see this approach to integrated pest management encouraged and expanded.

PROGRAM ELEMENTS

Pesticide Activities

As documented in Chapter I, the dollar value of AID-financed pesticide exported from the United States decreased substantially during the last 6 years. Tables 4 and 5 (pages 31 to 32 and 34 to 35 show that the dollar value of AID-financed pesticides declined from $28.1 million (13.9% of total United States pesticide exports) in FY 1970 to $11.0 million (1.9% of total United States pesticide exports) in FY 1975. This decline affected pesticides supplied for food production (crop protection) purposes as well as those supplied for public health programs (Table 22, page 60). According to available data for FY 1976 (see Table 23, page 61), the volume and value of pesticides financed by AID for food production purposes declined further in FY 1976. However, AID supplied larger quantities of DDT for antimalaria programs in FY 1976 than in FY's 1974 or 1975.

In January 1976, AID's "Interim Regulations on Provisions of Assistance for Procurement and Use of Pesticides" discussed in the preceding section became effective. Since that time, AID financing of pesticides for food production purposes has essentially been limited to pesticides for use on crops and pests registered within the United States by the U.S. Environmental Protection Agency. The interim regulations provide for some exceptions, including emergencies, and cases in which the intended target crops or pests are not grown or found in the United States. However, the procedures applicable to such exceptions, requiring personal determinations, in writing, by the AID Administrator and public notices in the Federal Register, have not been employed.

AID financing of DDT for public health uses is not restricted by the interim regulations.

Only limited specific information is currently available on the kinds and quantities of pesticides that AID may finance in FY 1977 and FY 1978. Factors that will influence future AID pesticide activities include the following:

* Overall AID program priorities.

* Availability of funds.

* Requests for pesticides and pest management assistance from less developed countries.

* The types of pest management problems encountered in regional development programs.

* Future AID policies, guidelines, and regulations concerning pesticide assistance that will be evolved from this Environmental Impact Statement.

Training and Technical Assistance Activities

As described in greater detail in Chapter I (see page 64), AID currently provides pest management training and technical assistance to less developed countries primarily through its contract with the University of California at Berkeley, "Pest Management and Related Environmental Protection Project." AID's contract with Oregon State University concerning "Weed Control Systems for Representative Farms in Developing Countries," although categorized as a research project, also includes training and technical assistance elements.

AID's current contract with the University of California runs through October 31, 1977. Program and budget proposals for the period November 1, 1977 to December 31, 1978, have been submitted by the University (9).

Training and technical assistance activities scheduled through October 31, 1977, include:

* Pesticide management workshop and associated training for residue laboratory personnel, Alexandria, Egypt, March 1977.

* Pesticide management workshop, Bangkok, Thailand, March 1977.

* Pesticide management workshop and associated training for residue laboratory personnel, Bogota, Colombia, October 1977.

* UNDP pest management training programs:

  Santiago, Chile, January to February 1977;
  Lima, Peru, April to June 1977; and
  Sao Paulo, Brazil, September to October 1977.

* Assistance to pesticide residue analysis laboratories in less developed countries desiring to upgrade their capabilities. Through a subcontract with the University of Miami, a quality control program is being developed in which some 20 laboratories will receive advice on the accuracy of their analyses, and assistance in correcting deficiencies. There are also provisions for training of qualified residue chemists from less developed countries who are able to come to Miami.

* Response to requests for technical assistance on pest and pesticide management problems as requested by AID field personnel or governments of less developed countries. The University of California project continues to provide AID with the expertise for quick, competent response to such requests.

Training and technical assistance activities scheduled for the period November 1977 to December 31, 1978 include:

* Pest management workshop and associated training, Sao Paulo, Brazil, November 1977.

* Pest management seminar and associated training, Dakar, Senegal, February to March 1978.

* UNDP pest management training program (location not yet determined), March 1978:

* Follow-up to the pesticide management workshop/seminars to be held in Egypt and in Thailand in 1977, and in the fall of 1978.

* Continuation of the quality control and improvement program for pesticide residue analysis laboratories in less developed countries at the University of Miami.

* Continuation of ad hoc technical assistance in pest and pesticide management on request.

In addition to these training and technical assistance activities being or to be provided through the University of California contract, many of the rural development and agricultural improvement projects in individual countries that are being administered by AID's Regional Bureaus contain pest management training and technical assistance elements, as described in greater detail beginning on page 128. Furthermore, AID's activities in this area include preparaton of manuals and other documents for purposes of supplementing training sessions and for independent distribution.

Research Activities

AID Research Programs--

In the interest of coherence and to avoid redundancy, information on funding for FY 1976 and projected future funding is included in the discussion of AID research programs in Chapter I (see page 73). This section, therefore, does not reiterate a project-by-project discussion.

Up to the present, AID's pest management-related research activities were scattered over at least three different programs, or key problem areas: crop production, livestock production technology, and health programs. AID is establishing a new unit for "pest control projects" which will include the contracts with the University of California at Berkeley (Pest Management and Related Environmental Protection project), Oregon State University (Weed Control Systems for Representative Farms in Developing Countries), U.S. Department of the Interior (Control of Vertebrate Pests), and North Carolina State University (Pest Management--Root-Knot Nematodes).

AID Support of International Agricultural Research Centers--

AID's support of international agricultural research centers increased steadily and substantially between 1969 and 1976, in step with increasing contributions from other members of the international donor consortium represented by CGIAR (see Table 25, page 89). It is anticipated that the future financial needs of these international centers will continue to increase as their activities expand, especially in the case of the recently initiated centers. Thus, demands on AID funds will continue to increase if AID continues to provide about 20 to 25% of the total basic support of these centers.

Other Pest Management Activities

In order to establish and operate successful pest management programs, many less developed countries need assistance not only in the form of pesticides, training and technical assistance, and research, but also in the building of in-country infrastructures for the development and operation of pest and pesticide management programs. Less developed countries' needs in this regard have already been outlined in some detail in Chapter I (see page 93).

AID's currently identified pest management activities (through CY 1978) did not include specific plans or activities addressed to assisting less developed countries in the establishment and operation of pest and pesticide management infrastructures. However, this important area of endeavor will receive higher priority in emphasis and resource allocation in the future (see Chapter VI, page 333).

HISTORICAL BACKGROUND AND CURRENT SETTING OF THE PUBLIC HEALTH AND FOOD PRODUCTION SITUATION IN LESS DEVELOPED COUNTRIES

This subsection is intended to provide insight into the problems of those less developed countries which AID assists in pest management activities. The discussion indicates the past and present problems and efforts of the people of these countries in their struggle to combat poor human health, malnutrition, and overall poverty.

The public health situation in the countries and regions identified for assistance by AID through CY 1978 is discussed for Latin America, Africa, and Asia. Individual countries and regions are addressed since data are available on the specific areas where AID public health activities will occur and the impacts that are anticipated. The food production situation, however, is discussed in the form of an overview of the past and present world food situation in less developed countries because only limited information is available on the specific pest management aspects of future AID food production and preservation activities.

Public Health

The public health situation in the countries and regions to be assisted by AID-financed public health programs involving pest managment activities is discussed for Latin America, Africa, and Asia. Public health programs planned by AID for the Near East are only in the development stage at this time.

Latin America--

Haiti, Bolivia, and Colombia are the only Latin American countries for which AID public health programs are anticipated through CY 1978. The Haiti program is the only one in which significant use of pesticides for the control of malaria is planned. The following description of the status of public health in Haiti provides perspective on Latin American health problems. (More detailed information on the public health status of the less developed countries included in the AID public health program is given in Appendix F.)

The Government of Haiti estimates that 75% of all morbidity in that country is due to endemic and communicable diseases. Of the endemic vector-borne diseases, malaria takes the greatest toll in human suffering. Life expectancy at birth in this country is 51 years, and the infant mortality rate is 147 deaths per 1,000 live births (10).

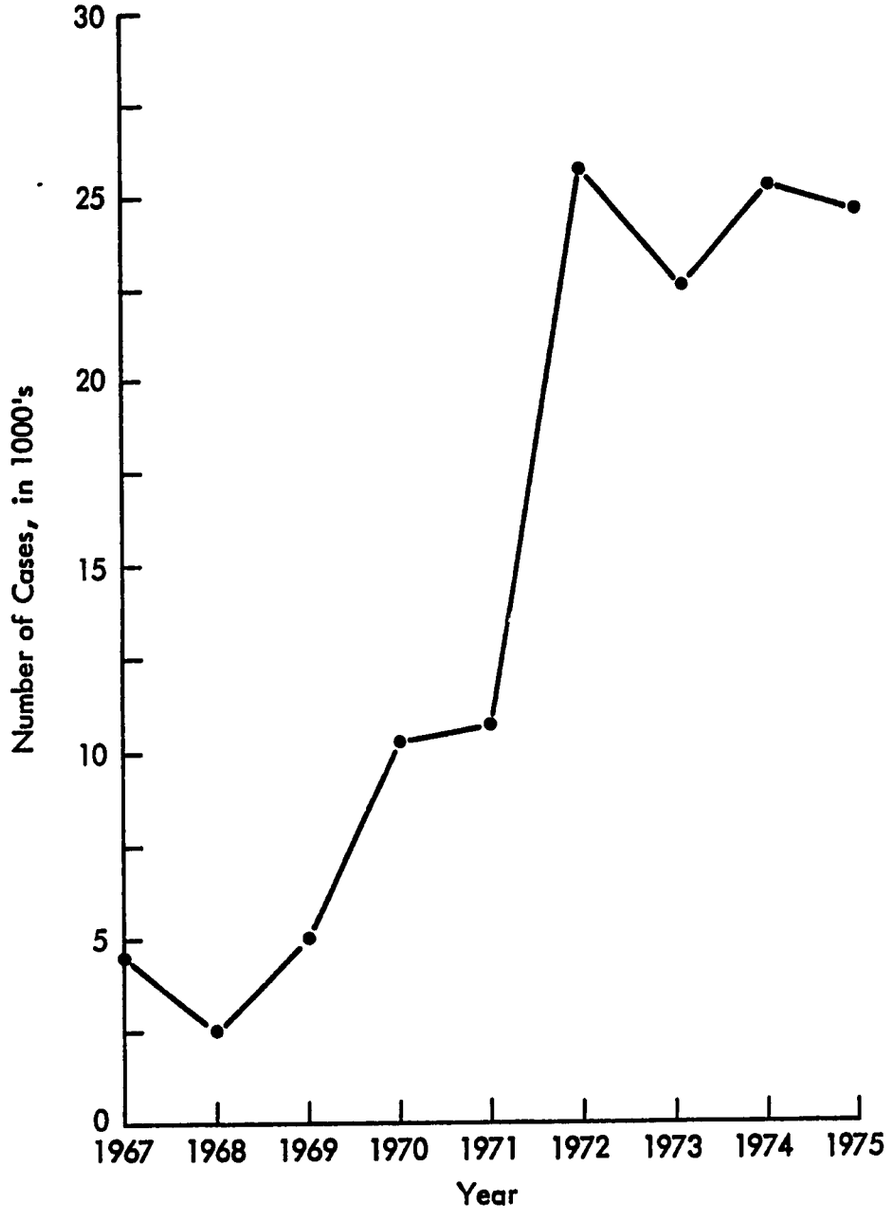
The Haitian malaria eradication program, which was initiated in 1961, has received assistance from AID, Pan American Health Organization (PAHO), United Nations Children's Fund (UNICEF), and the Haitian government. Semi-annual spraying of houses with DDT was adopted as an initial measure in January 1962, but malaria transmission continued. The lack of control was attributed in part to hurricane damage which required replastering and whitewashing over previously sprayed interior walls. DDT spraying was therefore increased to a quarterly basis in mid-1964. House spraying activity from 1965 to 1975 is summarized in Table 29.

Table 29: Domicile DDT Spraying in Haiti, 1965 to 1975

Year	House Sprayings
1965	651,106
1966	771,991
1967	394,860
1968	773,881
1969	551,493
1970	1,379,636
1971	1,698,576
1972	1,430,448
1973	769,929
1974	502,028
1975	< 100,000

The Haitian government adopted a mass drug administration program from 1964 to 1970 which led to a significant reduction in incidence of the disease. However, the drug program was terminated in 1970 primarily because of its high cost and refusal of Haitians to take the drugs (10). Spraying was subsequently augmented in 1971 to 1972, but malaria outbreaks and disease transmission continue to increase.

As indicated in Figure 4, the number of malaria cases in Haiti has risen sharply since 1971 increasing the potential for explosive malaria epidemics. House spraying and drug administration are still being practiced, although limited supplies of insecticides and drugs have forced curtailment in some heavily infected areas. Vector resistance to DDT has also become a significant problem.



Source: Developed from data in Reference 11.

Figure 4 - Number of Malaria Cases in Haiti, 1967 to 1975

Various evaluations of Haiti's program during the 1970's have produced conflicting recommendations; however, there is general recognition of the problems which have precluded malaria eradication (11). Living conditions in Haiti are a primary difficulty because of the poor sanitation status, primitive housing, and a generally migratory population which contributes to reinfection of areas previously rendered malaria-free. The climatic conditions exacerbate the poor housing situation and often reduce or negate the effectiveness of DDT spraying.

The program has been stymied by fluctuating financial contributions from supporting agencies, leading to discontinuities in program activities and an inability to respond properly to immediate needs.

Future assistance is needed in all areas: technical aid to improve treatment and control methodologies; organizational help to make control programs more effective and ultimately self-sufficient; and significant financial input to supply the insecticides, drugs, and supplies to implement control measures.

The malaria situation in Haiti, coupled with the general state of health of the country, has prompted its government to devote increasing attention and resources toward improving the overall health and well-being of its people. Emphasis has been placed on preventive medicine, and a first-order commitment given to malaria control as the starting point.

Africa--

AID activities in Africa involve three insect vectors of human health importance: (a) mosquitoes, vectors of malaria; (b) black flies, vectors of onchocerciasis; and (c) tsetse flies, vectors of trypanosomiasis. The history of control measures for each disease is discussed separately.

Malaria control--Funding of malaria control programs in Africa is currently limited to two countries: Zaire and Ethiopia. The history of activities in each country is discussed below.

Zaire--Among the endemic diseases in this country, malaria is a major cause for the low life expectancy of 44 years at birth. Accordingly, the Government of Zaire with the help of AID resources is embarking on a program aimed at reducing the incidence of this disease. Designed as a model malaria control program in the capital city of Kinshasa, efforts aimed at controlling this disease will be carefully studied, regulated, and monitored. Initial activities will be directed toward identifying vector resistance problems and ordering pesticides as appropriate for use in FY 1977. Other initial activities involve the use of larvicides such as Abate® to control vector populations.

Ethiopia--Malaria programs began in Ethiopia in the mid-1950's with pilot projects cosponsored by AID, WHO, and UNICEF. Between 1955 and 1964, AID-sponsored projects had reached a total of 5.0 million people. The Malaria Eradication Service was created in 1959; and in 1965, a joint Malaria Eradication Service/WHO study established a 14-year plan of operations with a goal of total eradication by 1980 (11).

Under the plan, Ethiopia was divided into four geographic areas, which were further subdivided into various zones and sectors. Each area was scheduled for four consecutive phases of control and eradication activities, as has been the standard practice for a malaria eradication program. However, financial problems delayed operations, and the program fell behind schedule. A 1970 review team drawn from WHO, AID, USPHS, and the Government of Ethiopia recommended the following steps to alleviate the problems: (a) maintain gains already achieved by continuing DDT spraying operations in a more discriminating manner; (b) conduct intensive antimalaria activities in agricultural or other development areas in all parts of the country; (c) base the timing of DDT spraying on epidemiological considerations; (d) use case findings in areas under antimalaria activities to evaluate trends in malaria incidence and detect epidemics; (e) integrate the Malaria Eradication Service and the Basic Health Service as soon as possible; (f) undertake a definitive study to determine whether malaria transmission can be interrupted in Ethiopia; and (g) collect baseline data for future evaluation of economic benefits from antimalaria activity in areas where attack operations are planned. Most recommendations were subsequently implemented, with satisfactory results. By 1971, farming and manufacturing activities had shown substantial growth in areas where malaria had been brought under control. Areas of land under cultivation increased 20% between 1965 and 1970, with malaria suppression having contributed to half this increase (11).

Problems in Ethiopian malaria eradication include the characteristic nomadic activities of the human population, failure in meeting financial commitments to the malaria eradication program which forced a reduction in the number of sectors under surveillance; and difficulty in determining reduction in incidence because of variations in past and present reporting ranges(11). However, the evidence indicates that areas which have received consistent DDT applications have achieved reductions. For example, the highly malarious sector of Awash has lowered its fever positivity rate from 18.1% in 1972 to 6.37% in 1973.

The 1975 plan of action, established in consultation with AID and WHO, called for the achievement and maintenance of an incidence level of 5% or below in 90 to 95% of the malaria eradication program-covered localities. Based on Ethiopia's past experience in controlling localized epidemics, this goal seems to be realistic.

Onchocerciasis control in Sahel, Central, and Western Africa--Epidemiological data on onchocerciasis in the seven countries of the AID/WHO program area (Benin, Ghana, Ivory Coast, Mali, Niger, Togo, and Upper Volta) were collected between 1968 and 1972 by various health services in

the different countries. Levels of endemicity were then classified according to four broad categories: 0 to 9.9% - sporadic cases; 10 to 39.9% - low endemicity; 40 to 69% - medium endemicity; and 70% or more - high endemicity. Based on a WHO estimate by extrapolation from existing figures, the total number of humans infected in the program area may exceed 1 million. While the overall prevalence of blindness caused by this disease is uncertain, it is estimated that at least 5% of the general population is so affected (12). Data were subsequently evaluated to determine the geographical distribution of onchocerciasis and related to population densities and agricultural productivity potential of the land. In this manner, a great deal was also learned about the socioeconomic implications of this disease.

Tsetse fly control by sterile insect release--Trypanosomiasis, or African sleeping sickness, is transmitted to humans by the bite of an infective tsetse fly. With incidence of infection as high as 30% of the population in some endemic regions, this disease is a significant contributor to human suffering. Since both domestic and wild animals, as well as man, may be reservoirs of infectious agents, control of the disease is quite difficult. One approach to control being pursued by AID in Tanzania is the sterile insect release method. The sterile insect release method has been highly effective in controlling the tsetse fly in small-scale tests conducted in an isolated area in Rhodesia, and is scheduled for more widespread testing in Tanzania under the more normal conditions of large land areas.

Asia--

AID funding of malaria control programs is most extensive in Asia. The Asian programs are anticipated in four countries: Indonesia, Nepal, Pakistan, and Sri Lanka, and are for the most part, continuations of previous malaria control measures. The history and current status of malaria control programs are discussed for each of the four countries.

Indonesia--The first malaria control program in Indonesia was initiated in 1951, at which time there were approximately 20 million cases annually throughout the country. The program was expanded so that by 1964, all provinces of Java and Bali were included and had, in fact, become practically malaria-free. However, in 1965 political and economic upheavals caused drastic cutbacks in the program, and United States assistance was terminated at this time (11). Subsequent shortages of funding and supplies resulted in the cessation of house spraying, as well as disruption in surveillance programs and field operations. In 1972, the government requested that AID reinstitute its assistance to the malaria eradication program, and by 1974 AID had agreed to loan Indonesia $24.8 million to supplement the country's $46.2 million, 5-year malaria control program.

Future needs of the malaria control program in Indonesia include the reduction of transmission in the Central Islands (Java, Bali, and Madura) and in priority areas of the Outer Islands through the following methods:

house spraying, the provision of treatment for existing malaria cases, training and technical assistance, and funding for research activities.

Nepal--The first organized malaria control efforts in Nepal were initiated in the mid-1950's under two pilot projects cosponsored by AID and WHO. In December 1958, under an agreement between AID and the government of Nepal, the Nepal Malaria Eradication Organization was founded. As a result of this program malaria incidence throughout Nepal was reduced from several hundred thousand cases annually to approximately 2,500 cases in 1972 (13).

The original plan had established a target date of 1971 for malaria eradication; however, a number of problems precluded attainment of this goal, and the target was postponed until 1973. These problems included poorly developed communication facilities; a lack of qualified administrative and technical personnel; large population movements which fostered malarial transmission; the replastering of houses, which reduced the effect of DDT spraying; and a large portion of the populace sleeping outside and thus susceptible to bites by infected mosquitoes (11).

In 1971, AID began withdrawal of technical assistance as a move toward multilateralization; in June 1972, the agency elected to terminate all support. However, as an interim measure toward assumption of responsibility by the Nepal Malaria Eradication Organization, AID provided a terminal grant of $1 million for supplies, training, and assistance in the program transition. By this time malaria control efforts had reached 5.9 million people, and 80% of the population had been moved into the consolidation phase of malaria control. An evaluation team visiting Nepal in early 1972 reported a malaria incidence of only 2.44 per 1,000 population, and 0.14 per 1,000 in the consolidation group.

By 1973, however, an AID regional malaria officer evaluating Nepal's malaria eradication program noted a gradual increase in malaria incidence, in spite of the fact that 6.2 million of the 6.8 million people living in malarious areas were under the Nepal Malaria Eradication Organization program. Subsequently, in 1974 the Nepal Malaria Eradication Organization requested a joint AID/WHO/Nepal government evaluation for the purpose of investigating the increase in disease incidence. This team noted vector resistance to DDT, primarily in limited areas of the outer terai of Nepal, and resistance-tolerance of chloroquine among the malaria parasite *Plasmodium falciparum* in the eastern portion of the country. This latter situation was believed to be the result of continual migration of Nepalese workers between the Indian areas of Assam and eastern Nepal. The evaluation team recommended that areas populated by 1.3 million people be returned to attack phase to combat the increasing number of malaria cases.

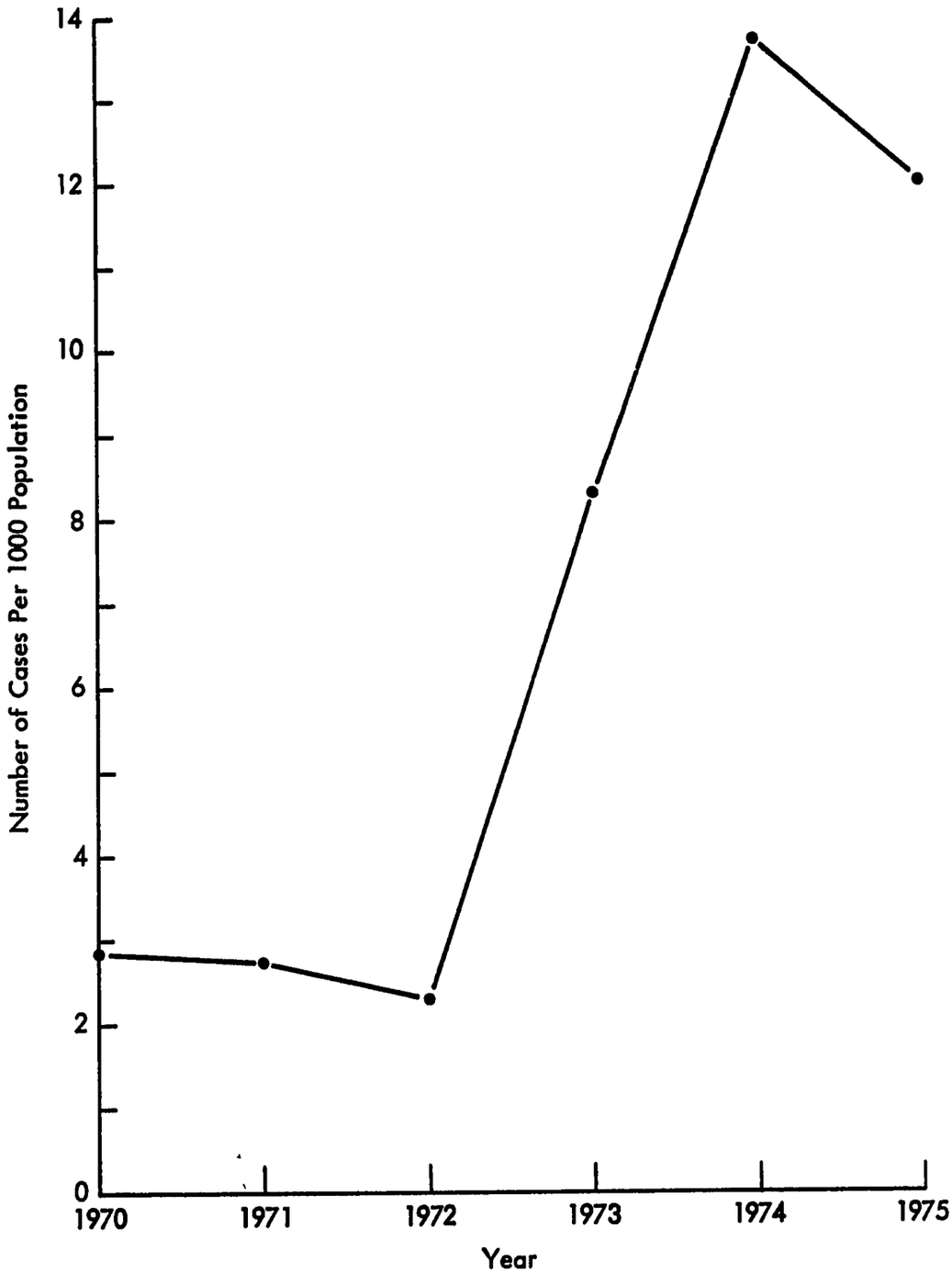
A 1975 joint assessment summarized the major problems which Nepal has experienced in its eradication program. Technical problems included the vector and parasite resistance previously discussed, a shortage of insecticide and supplies necessary for house spraying, and the rising malaria incidence in India, which was in turn affecting incidence in Nepal. Administratively, Nepal was suffering personnel losses, the abolition of key eradication program positions, inadequate training programs, and deterioration in transportation services for field operations. Financially, increasing insecticide and drug costs were straining the eradication program budget, seriously impairing the ability of the malaria eradication organization to respond to immediate needs.

There has been an increase in malaria incidence in Nepal since 1972, as depicted in Figure 5. From a low of approximately 2.4 cases per 1,000 population in 1972, incidence rose to 13.8 in 1974, before declining slightly in 1975 to 12.0.

The problems of vector resistance to insecticides and parasite resistance to antimalaria drugs must be addressed as future needs. Increased epidemiological investigations are needed in both Nepal and India; also necessary are evaluation of drug treatment and field operations, and better screening mechanisms at border crossing points. Training programs must be strengthened as a vehicle for effective implementation of the program technology. Insecticides must also be provided in sufficient amounts to supply needs in attack areas.

Pakistan--In the early 1960's, Pakistan had a model antimalaria program, providing an effective, yet economical approach to disease control. Funded by AID, WHO, and the government of Pakistan, the 14-year program was initiated in 1960 with the eradication of malaria in East and West Pakistan as its target. However, since 1968-1969, the program has experienced serious administrative and financial problems which have resulted in a major deterioration of malaria control activities (11,14). Extensive vector resistance to DDT has developed, and the Pakistan government has given a lower priority to the malaria program.

An epidemic in Karachi in 1968, comprising 250,000 cases, led to the reinfection of previously malaria-free areas where house spraying had been interrupted. By 1973 malaria cases were reported at approximately 600,000, partly the result of a flood-related epidemic in Punjab and Sind provinces. Malaria has reached near-epidemic proportions in Pakistan, with conditions considered to be worse than they were in 1961, prior to the initiation of the malaria eradication program. The 1974 estimates indicate as many as 10 million cases, with a possible rise to 23 million by 1979 if the situation is not controlled and transmission interrupted (14).



Source: Developed from data in Reference 11.

Figure 5 - Malaria Incidence in Nepal - 1970 to 1975

Pakistan has experienced a multitude of problems in its malaria program as evidenced by disease resurgence. Recrudescence was caused by a number of technical and management problems, including inadequate financing of the maintenance phase of the program; supply and equipment maintenance difficulties; an increase in urban malaria; an increase in vector resistance to DDT; unworkable administrative rearrangements; lack of a permanent health infrastructure to ensure continuation of eradication measures; and personnel shortages.

Based on Pakistan's lack of strategy to deal with the malaria problem and extensive agency commitments to East Pakistan's relief and rehabilitation programs, AID withdrew its loan financing in late 1971 (14). However, in FY 1975, AID did provide a $35 million malaria control loan and a grant of $25.3 million in United States-owned rupees, with the objective of achieving an incidence of no more than 500 cases per million population by 1979.

It is obvious from the foregoing discussion that Pakistan needs assistance at all levels to solve its malaria problems. Vector resistance must be addressed and overcome; financial aid is vital to procure insecticides; and ultimately, personnel and administrative problems must be resolved if the program is to be successful.

Sri Lanka--Following the very successful DDT-based malaria eradication program of the early 1950's, Sri Lanka had an extremely low level of malaria for many years. Basic control measures used include DDT house spraying and surveillance activities. After termination of the DDT program a significant increase in disease incidence occurred, becoming an epidemic in 1968. By 1974, Sri Lanka reported 400,000 cases of malaria.

Sri Lanka has experienced difficulties in coordination of control efforts between the malaria service and the basic health services of the country, resulting in disruption of the warning system in case of potential epidemic situations. In 1974, total per capita expenditure for malaria control (from all sources) was $0.20 (11). AID has under consideration a proposal for assistance to the Sri Lanka malaria program in the form of a loan.

Food Production

The ability of world agriculture to feed an ever-expanding world population has become a subject of increased concern over the past 15 years. The world food situation has become serious, even precarious, as food shortages in different parts of the world appear, year after year. There were major shortages in the early 1920's following World War I, in the late 1940's and early 1950's after World War II, in the mid-1960's after 2 years of drought on the Indian subcontinent, and most recently in 1972, when world grain production fell 35 million tons and the U.S.S.R. bought heavily on the international market. Today, however, the food shortages are largely due to

continuing deficits of food production in many of the developed and less developed countries as the world population grows and food demand rises. The major exporting countries can no longer produce enough food to counterbalance these deficits, and the food situation worldwide has become grave.

The International Food Policy Research Institute has estimated that if the grain production trends of the past 15 years continue, the food grain deficit of less developed countries with market economies will be about 100 million tons a year by 1985-1986. If the lower rate of increased food production of the past 7 years prevails instead, the annual deficit of the less developed countries could reach a staggering 200 million tons. This estimate makes the situation extremely grave when taken together with present day estimates that a billion people suffer from hunger and malnutrition, that 10 million children worldwide are so seriously malnourished that their lives are at risk, that 400 million people live on the edge of starvation, that 12,000 people die of hunger each day, and that in India alone 1 million children die each year from malnutrition (15,16).

The nutritional deficiencies of less developed countries are difficult to estimate. Malnutrition may be due to a number of factors: lack of necessary food intake, imbalance of the protein-caloric requirement, diets lacking in one or more essential nutrients (vitamins or minerals), and illness of genetic or environmental origin which prevents digestion or absorption of a needed constituent.

Two methods have been used to estimate the protein-caloric intake or the degree of malnutrition in less developed countries. In each case a balance sheet is constructed in which production, changes in reserve and purchases of food are balanced against food used for seed, animal feed and waste. The difference is then the estimate of human consumption. The adequacy of the national diet can then be estimated using the FAO table of nutritional requirements. The approach has several drawbacks: difficulties of estimating crop production, lack of reporting of food grown for family consumption, difficulty of estimating postharvest loss, and differences in ability of families to purchase food. The method does, however, provide a rough estimate of the state of nutrition of a country or region.

The second approach is to compile data from hospital records and health surveys. Statistics on illness are unreliable in developed countries and even more so in less developed countries. Health survey data are difficult to develop and criteria for assessing malnutrition are not standardized. However, studies of this nature that have been conducted in 45 countries of Asia, Africa, and Latin America on 200,000 preschool children indicate that at least some degree of protein-caloric deficiency exists in over 98 million children in those parts of the world. Percentages range from 5 to 37 in Latin America, 7 to 73 in Africa, and 15 to 80 in Asia excluding China (16).

The United Nations Economic and Social Council studied the food production growth rates of 71 developing countries between 1953 and 1971 (16). Trends in food production were traced for each country on the basis of how each country's average annual change in food production compared with the country's change in population and in domestic demand for food, a category that reflects not only population increases but also the economic status of the people and their changes in preferences for food, e.g., a tendency to eat more meat. In 24 of the nations, the rise in food production failed to keep pace with population growth; in 17 nations the growth of food production exceeded the population growth but fell short of the change in domestic food demand; and in 30 nations the rise in food production exceeded population growth and rise in domestic demand. Table 30 lists the nations studied and their status during this time period.

While the estimates of malnutrition of less developed countries are crude at best, the situation they reflect is clear. A sizable fraction of the population of less developed countries suffers from nutritional deficiencies. The situation is probably more serious than gross statistics would indicate because of a lack of ability of a major share of these populations to purchase food even if it were available and the logistical problem of getting food to the people who need it. Many of these countries are highly agrarian with 50 to 80% of their people in rural areas farming small acreages. The people are often highly reliant on their own production to supply their food needs. Natural disasters such as floods, drought and pest infestation can result in severe local food deficiencies which are not always reflected in a country's statistics.

The ratio of usable land to population in these countries is dwindling; in a number of countries the amount of cultivated land per person is less than an acre. Even a few decades ago food production could be increased in most countries by bringing additional land under cultivation or extending grazing areas. Now that option is disappearing in many regions. Moreover, as land has been divided repeatedly among generations of heirs, most family holdings have become extremely small (16).

Another handicap for many of these countries is their small size; in nearly 80 of these countries the population is less than 5 million, and in more than 30 it is less than 1 million. Such nations cannot expect to develop for themselves the full range of scientific and other professional services required in fields that are important to development; they must rely upon external resources (16). The less developed countries' lack of institutions and trained personnel is exacerbated by the fact that many of these countries are newly independent. Of the countries listed by the United Nations as being least developed or as being "most seriously affected" by recent economic stresses, 36 have become independent since 1945, 29 of them since only 1960.

Table 30: Food Production Growth Compared to Population Growth and Growth of Domestic Food Demand, 1953 to 1971

	Developing Countries		
Food production growth failed to equal population growth	Algeria		Nigeria
	Zaire		Syria
	Uruguay		Chile
	Chad		El Salvador
	Haiti		Indonesia
	Tunisia		Dominican Republic
	Mauritius		Guyana
	Benin		Kenya
	Jamaica		Paraguay
	Jordan		Iraq
	Uganda		Saudi Arabia
	Trinidad-Tobago		Philippines
Food production growth failed to equal growth of domestic food demand	Argentina		Pakistan
	Ethiopia		Peru
	Burma		Colombia
	India		Turkey
	Mauritania		Iran
	Sierra Leone		Zambia
	Mozambique		Republic of Korea
	Morocco		Panama
	Cambodia		
Food production growth equaled or exceeded growth of domestic food demand	Angola	Brazil	West Malaysia
	Madagascar	Niger	Nicaragua
	Tanzania	Guatemala	Ecuador
	Cameroon	Honduras	Thailand
	Senegal	Sudan	Togo
	Gabon	Malawi	Costa Rica
	Sri Lanka	Bolivia	Cyprus
	Egypt	Upper Volta	Lebanon
	Ghana	Ivory Coast	Venezuela
	Rhodesia	Mexico	Central African Republic

Source: Reference 16.

Resources that are vital to the improvement of the agricultural conditions in less developed countries include capital, agricultural research, and agricultural inputs such as equipment, fertilizers, seeds, and pest management systems. Much has been done recently to help provide the resources necessary to elevate the less developed countries to a status of agricultural self-sufficiency.

Pest control can be expected to become increasingly important in meeting the nutritional needs of less developed countries.

FOOD PRODUCTION AND PRESERVATION PROGRAMS

The major emphasis of AID programs is in those areas where food production and preservation problems are most severe and in countries that are least capable of implementing their own remedial measures. AID's overall program currently emphasizes assistance to countries designated by the United Nations as "Really Least Developed" and those countries designated as "Most Seriously Affected" by price increases of oil and other imports--countries often referred to as the "Poorest of the Poor" (17).

Africa (17,18,19)

Figure 6 shows the African countries scheduled for all types of development assistance in FY 1977, including pest management assistance. Current and projected AID programs relating to food production and preservation involve 34 African nations (see Table 31). Nine African nations currently receive or are projected to receive assistance in the food and nutrition area through country-specific programs, and 25 additional countries receive assistance or benefit in some other way from African regional or interregional multidonor programs such as those in the Sahel, Central and West Africa, and the southern Africa regions.

Several natural disasters greatly compounded problems of food production facing many countries in parts of Africa in the early 1970's, and subsequently had a major influence in defining target areas for AID program assistance. The major drought of 1967 to 1973 in the Sahelian ecological zone, combined with several major pest outbreaks, devastated the agricultural capability of a number of already poor countries, and spawned multidonor programs in the Sahel and Central and West Africa regions. AID assistance under the Sahel regional program in the food and nutrition category amounted to $3.7 million in FY 1975, $38.7 million in FY 1976, and is projected to be $43.5 million in FY 1977. This represents more than a tenfold increase in annual assistance to the Sahel region in the food and nutrition category over the 3-year period. In the same period, for comparison, AID assistance to all African countries assigned to the AID African Bureau increased from $51.7 million to $134.9 million, less than a threefold increase.

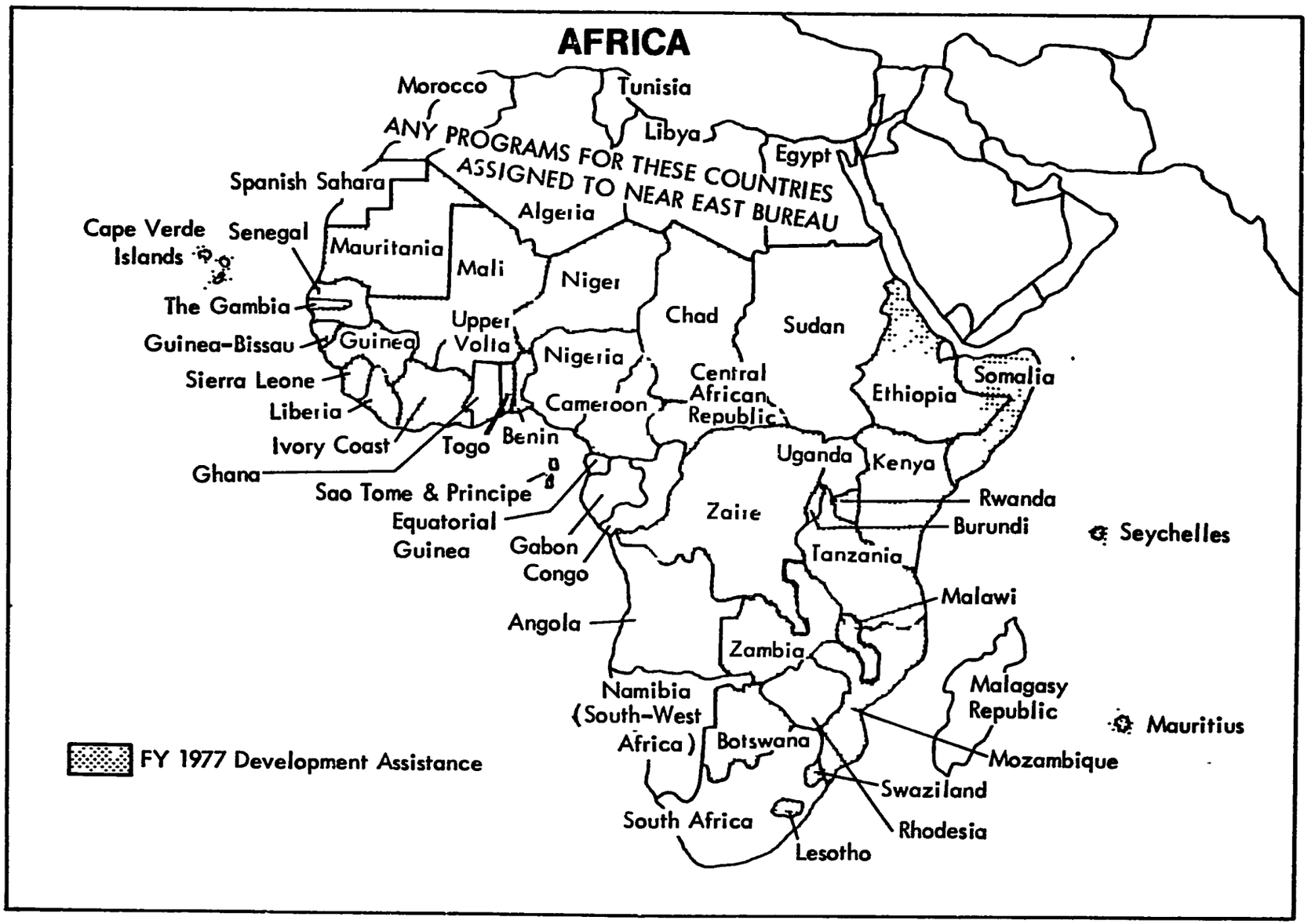


Figure 6 - FY 1977 Development Assistance in Africa

Table 31: Currently Identified Food Production and Preservation Programs in Africa

Country	Project/Program	Program Element[a] P.A.	O.P.	T/TA	R.	Comments
Ethiopia	Upper Didessa Development, Grant No. 663-51-121-179	b/	X	X		No specific mention of pesticide use, but do plan malaria control, tsetse fly control, multiobjective; may include pesticides.
Ethiopia	Agriculture Sector Development, Grant No. 663-51-130-181			X		No specific mention of pest management, but probably some technical assistance (with regard to "improved agriculture techniques"); no pesticides
Ethiopia	Rural Agricultural Development, Grant No. 663-55-130-167			X		"Technical assistance in horticulture and entomology"; pest management training and technical assistance
Rwanda	Farm Hand Tools, Grant No. 696-11-130-103		X			Manual control of weeds
Rwanda	Participant Training, Grant No. 696-11-610-102			X		Training in food storage and marketing; seed research probably includes pest control and development of resistant varieties
Sierra Leone	Agricultural Research, Grant No. 636-11-110-102			X		Establish agricultural research organization that will probably lead to research in pest management and development of resistant plant varieties
Tanzania	Seed Multiplication, Grant No. 621-11-130-092				X	No specific mention of pest management; action to establish four seed farms; possibly breeding for resistance and other pest management research
Tanzania	Agricultural Research, Grant No. 621-11-110-107				X	No specific mention of pest management; research leading to improved agronomic and cultural practices
Tanzania	Agricultural Manpower Development, Grant No. 621-11-190-119			X		No specific mention of pest management; training in all aspects of agriculture; potentially, training in use of pesticides
Tanzania	Food Crop Production, Grant No. 621-11-110-126	b/		X		Pesticides mentioned as previous activity; probably technical assistance; pesticide activity (use of DDT) funded by host country or other non-AID donors

Table 31 (Continued): Currently Identified Food Production and Preservation Programs in Africa

Country	Project/Program	Program Element[a/] P.A.	O.P.	T/TA	R.	Comments
Tanzania	Agricultural Sector Loan (Loan - No Number)				X	Loans to support programs in "grain storage and institutional and research infrastructure"
Zaire	INERA Support, Grant No. 660-11-560-064				X	No specific mention of pest management; full array of agricultural crops research; possibly includes pest management research
Sahel, etc.	Entente Food Production, Grant No. 626-11-130-203	X		X		"Increase production of staple food crops"; includes financing for pesticides and training and technical assistance; host country purchases pesticides with funds provided by AID (BHC, endosulfan, trichlorfon)
All Sahel countries	Sahel Crop Protection, Grant No. 625-11-130-916	X	X	X	X	Emphasis on food crops; other donors; all aspects of pest management
Chad and Cameroon	Lake Chad Livestock and Mixed Agriculture, Grant No. 625-11-130-XXX	X	X		X	No specific mention of pest management; includes "commodities" and "seed and other agricultural inputs"; probably resistant seed development, some pesticides, cultural practices to reduce pest losses
Cameroon (Sahel programs)	North Cameroon Seed Multiplication, Grant No. 631-11-130-202	b/	X		X	No specific mention of pest management; probably some pesticides used on seed farms for seed protection, development of resistant varieties, improved cultural practices to reduce pest losses
Cameroon (Sahel programs)	North Cameroon Livestock and Agricultural Development, Grant No. 631-11-110-XXX			X		No specific mention of pest management; "integrated rural development"; probably includes some pest management, but no pesticides
Cameroon (Sahel programs)	North Cameroon Livestock and Agriculture (Loan - No Number)	X		X		Includes "chemicals and animal health supplies"; some pesticides and technical assistance
Mauritania (Sahel programs)	Mauritania Dieri Soil Crop Research, Grant No. 628-11-110-XXX			X	X	No specific mention of pest management; includes "commodities" and "seeds and fertilizers"; probably research and technical assistance; no pesticides

Table 31 (Continued): Currently Identified Food Production and Preservation Programs in Africa

Country	Project/Program	Program Element[a] P.A.	O.P.	T/TA	R.	Comments
Guinea (Sahel programs)	Guinea Agricultural Production and Training, Grant No. 675-11-130-201			X		No specific mention of pest management; probably training and technical assistance; no pesticides
Mali (Sahel programs)	Mali Crop Production, Grant No. 688-11-130-202	b/		X	X	No specific mention of pest management; "improved seed" development; probably some use of pesticides for demonstration
Mali (Sahel programs)	Mali Food for Work, Grant No. 688-11-995-204		X			Hand tools for control of weeds
Mali (Sahel programs)	Mali Livestock Sector, Grant No. 688-11-130-203	X	X	X		Specifies tsetse fly eradication program, but not methods; includes pesticides (probably endosulfan); other pest management activities
Niger (Sahel programs)	Niger Range and Livestock, Grant No. 683-11-130-202	b/		X		No specific mention of pest management; possibly pest management with respect to range management and livestock health; possibly some pesticides
Niger (Sahel programs)	Niger Cereals Production, Grant No. 683-11-130-201	X		X		Mostly technical assistance and training; "monitor use of insecticides, etc."; some BHC and endosulfan
Upper Volta (Sahel programs)	Village Livestock Development, Grant No. 686-11-130-203	b/		X		No specific mention of pest management; perhaps some use of pesticides to control disease vectors of livestock
East Africa (Regional)	East African Food Crops Research, Grant No. 618-11-110-657			X	X	No specific mention of pest management; probably research, technical assistance, and hybrid seed development
Africa (Regional)	Rice Research and Production, Grant No. 698-11-190-382			X	X	No specific mention of pest management; probably research, technical assistance, and training

Table 31 (Concluded): Currently Identified Food Production and Preservation Programs in Africa

Country	Project/Program	Program Element[a/]				Comments
		P.A.	O.P.	T/TA	R.	
Africa (Regional)	Semi-Arid Food Grain Research and Development, Grant No. 698-11-130-393				X	No specific mention of pest management; probably research in plant breeding and planting systems
Africa (Regional)	Mano-River Union-Rice Storage Technology and Design, Grant No. 698-11-199-XXX			X	X	No specific mention of pest management; probably some pest pest control relating to storage, research, and technical assistance; no pesticides
Africa (Regional)	Livestock Production, Grant No. 931-11-130-A05	X			X	Control of tsetse flies - Africa; research on ecology and control of the vector ticks; also some pesticides
Angola, Cape Verde, etc.	Project Support, Grant No. 659-15-998-002	X	X	X		Project not yet completely defined; includes "plant protection and dry land crop production"; some pesticides (BHC), technical assistance, and training

Note: X = Anticipated activity

a/ P.A. = Pesticide activity
O.P. = Other pest management activities not involving pesticide activity
T/TA = Training/technical assistance
R = Research

b/ Possible activity

AID's activity in Africa expanded significantly with the independence of the former Portuguese colonies in Africa. Angola, Cape Verde, Guinea-Bissau, Mozambique, Sao Tome, and Principe all gained their political independence during the period from September 10, 1974 to November 11, 1975, and with the exception of Mozambique, AID is committed to helping these countries achieve their economic independence. In response to this commitment, AID is developing a program to assist these countries in improving their food production capabilities, a program that includes pest management activities.

AID assistance in the category of food production and preservation is directed toward several broad objectives. A major portion of AID's food production program assistance is designed to increase the productivity and income of the small farmer. Two specific aspects of this objective are to increase the production of food crops which can be grown in semiarid lands, such as sorghum and millet, and to increase the production of livestock through range improvement and the control of disease. It is recognized by AID that these broad objectives can only be accomplished in many areas through integrated rural development, incorporating many aspects of improving the quality of life of the rural poor.

Many of the program activities and specific projects designed to accomplish the broad program objectives involve pest management activities, but a pest management program does not exist in the sense of a separate, well-defined program with specifically stated objectives. Pest management activities are generally subcomponents of larger projects with broad, multifaceted objectives. The magnitude of the pest management component of many proposed projects is difficult to determine, either because it is not a major part of the project activity or because the magnitude has not yet been determined. The same difficulty exists in documenting the magnitude of the pest management component of past projects because the magnitude was not determined prior to project implementation, and the pest management activity that occurred is generally not separately documented because it was considered incidental to the major activities of the project. However, pest management activity is an integral component in accomplishing the major objectives of the overall AID program in food production and preservation.

Many AID projects are designed to assist countries in developing their own capabilities for improving agricultural production, rather than actually carrying out the production activities. Consequently, the emphasis of pest management activities is in the areas of technical assistance, training, and research rather than on pesticide activities. Pesticide activities are included in AID projects when they are determined to be necessary to accomplish the objectives of a project that represents an integral step in processing toward the goal of economic self-sufficiency.

Pesticide Activities--

Pesticide activity is clearly defined within the scope of a number of AID-supported food production and preservation projects in Africa, but for many other projects, it is difficult to identify any pesticide activities, or to determine the magnitude or extent of any such activities. Information

from proposed FY 1977 projects indicates that some level of activity "conducted, supported, financed, or otherwise assisted by AID for the procurement or use of pesticides" is anticipated in a maximum of 16 African nations.

Most of the AID-anticipated pesticide activities are concentrated in the Sahel region. Projects involving pesticide activities emphasize the establishment of cereal grain production capabilities and the rebuilding of livestock herds.

The main target crops for pesticide activities are sorghum and millet in semiarid areas, and rice and maize in those areas where rainfall is adequate or where irrigation water is available. Pesticides used to enhance livestock production are directed toward the control of disease vectors of livestock such as tsetse flies, or in some instances, to improve range production.

Pesticides are occasionally used indirectly in food production and preservation programs, for research and training on demonstration projects, and for miscellaneous uses such as the protection of seeds on seed research farms. Examples of pesticides that have been used are BHC, endosulfan, and trichlorfon.

Suspended or cancelled pesticides--AID does not currently use any pesticide for which the registration for use in the United States has been finally suspended or cancelled in food production and preservation programs in Africa. The registration for technical BHC has been withdrawn by EPA at the request of the manufacturer after it was placed on the Rebuttable Presumption Against Reregistration List. Formulated BHC products continue to be available for registered use.

Related pesticides--The chlorinated hydrocarbon, BHC, is projected for potential use in two FY 1977 food production and preservation programs in Africa. Neither project is completely defined as yet, and the amounts projected for use and the locations planned for application cannot accurately be determined at this time. One project, however, involves the "Entente" countries in the Sahel regional program (Ivory Coast, Togo, Benin, Niger, and Upper Volta) covering a significant land area and thus posing the possibility of extensive use of the pesticide. The other project involving BHC is under the "Angola, Cape Verde, Guinea-Bissau, Mozambique, Sao Tome, and Principe" program. This proposed project is currently in review. Plant protection is a major objective, but it has not been determined to what extent any pesticides (including BHC) will be involved.

All other pesticides--The only other specific pesticides that have been identified for projected use are endosulfan and trichlorfon. Both of these insecticides are projected for use in projects with plant protection activities; the level of use of each is not yet specifically defined.

Other Pest Management Activities--

Several AID-sponsored projects in Africa contain pest control activities that do not involve the use of pesticides. The use of nonchemical methods of

pest control is small in comparison to that of chemical methods, but the activities may be significant on a local scale both in their economic and environmental impacts, and in their effects on pests.

One method of nonchemical pest control is the alteration or destruction of habitat of vectors of various diseases. While this type of activity is related more to health programs than food production and preservation, it is pertinent in that rural areas must be free of both human and livestock disease vectors to permit agricultural development. No activities of this type, however, are described for proposed FY 1977 projects.

Of less importance environmentally, but of much significance economically, are projects designed to assist in the manual control of weeds. For example, the provision of farm hand tools in Rwanda takes advantage of the high unemployment conditions while greatly increasing productivity of the agricultural sector.

Preventing damages caused by pests is a major concern of several other types of projects, although they are not defined exclusively as AID pest management projects in Africa. One such type of project is the construction of storage facilities designed to reduce the loss of grain stocks due to any number of potential hazards, one of which is pests. Also included in this category are improved cultural practices that reduce pest losses such as timing of planting and harvesting, or improved methods of cultivation.

Technical Assistance and Training--

Technical assistance and training is by far the major component of AID's pest management program in Africa. Of 31 food and nutrition projects proposed through the African Bureau in FY 1977 that contain a pest management component, 22 projects involve activities that can be defined as technical assistance and training. Technical assistance supported by AID covers all aspects of agricultural production, including pest management. Technical expertise is provided on the most effective methods of controlling pest losses and, where pesticides are used, expertise is provided on proper handling and use, and on the timing and rates of application that should be used to maximize effectiveness while minimizing adverse environmental and health effects. The pattern of technical assistance is to locate individuals from the United States with expertise in the areas of crop and livestock production in the less developed countries (LDC's).

Training activities sponsored by AID are designed to disseminate information on effective methods of controlling pest losses, and to educate agricultural workers in the handling and use of pesticides. Training is accomplished both by bringing individuals from recipient countries to the United States and by training individuals within the recipient countries to disseminate information to rural areas.

Part of the incentive for training and technical assistance stems from the assumption that most LDC's use (or will use) pesticides procured from other sources in addition to (or in the absence of) pesticides provided by AID and that many adverse effects in both the environmental and health categories can be avoided through training and technical assistance in the proper use and handling of all pesticides, as well as other aspects of integrated pest management.

Research--

Some of the projects supported by AID relating to pest management are directed toward improving methods of pest control and avoiding pest losses under country-specific or geography-specific conditions. Pest problems in Africa vary significantly from one region or country to the next, and improved methods of reducing pest losses that have been developed in the United States may not be applicable or effective in other regions of the world. In addition, varying economic and social conditions may limit the number of feasible options open to a given country for reducing pest losses. For these reasons, it is necessary to conduct research activities that address pest problems and related conditions prevailing in aid-recipient countries.

Types of research supported by AID in Africa include the development of resistant plant varieties, improved cultural and agronomic practices, and more effective utilization of pesticides, e.g., optimum timing and rates of application.

AID also supports research activities in the United States that are applicable to more general pest problems. For example, research into characteristics and life cycles of pests, economic and institutional factors affecting pest management, and other aspects of integrated pest management are types of activities supported by AID.

Latin America (20)

Figure 7 shows the Latin American countries scheduled for any type of development assistance in FY 1977, including pest management assistance. AID's food and nutrition program in Latin America pursues goals similar to the overall program goals of increasing domestic food supply and increasing food crop production for domestic markets (see Table 32). Inherent in these goals are the general objectives of increasing small farmer income and agricultural production.

Methods for achieving the goal of increasing small farmer income in Latin America are concentrated on institutional and economic factors inhibiting integrated rural development. This strategy differs to some extent from the strategy pursued in Africa, for example, in that less emphasis is placed on basic crop production activities. Several factors have contributed to this preferred situation. In general, Latin American countries have relatively higher per capita incomes, a more favorable population-to-land area ratio, and an abundant natural resource base. Because of considerable agricultural progress in the last decade, Latin American countries have progressed beyond the primary problem of establishing a basic subsistence production capability, and now face the more secondary problems of improving the quality of life in rural areas and maintaining production capabilities that outpace population growth rates.

Figure 7 - FY 1977 Development Assistance in Latin America

Table 32: Currently Identified Food Production and Preservation Programs in Latin America

Country	Project/Program	Program Element[a/] P.A.	O.P.	T/TA	R.	Comments
Bolivia	Basic Foods Production and Marketing, Grant No. 511-11-190-451, FY			X	X	Research to improve production with small farm technology and training and technical assistance to local personnel; may involve pesticides
Bolivia	Agriculture Sector Loan II, FY 1977 to FY 1980				X	Agriculture research possibly in livestock area
Bolivia	Title Not Available (1976-1978)	X		X		Annual amount $3,000 to $5,000; pesticides purchased locally; technical assistance to small farmers for crop production improvement $10,000 to $18,000 annually; to locally purchase pesticides through AID-financed agricultural credit
Chile	Agriculture Sector Loan No. 513-L-037					Loan authorized October 18, 1967, for $23,794,000; amount dispersed as of December 31, 1975, $21,637,000; pesticides purchased locally through agricultural credit loans
Chile	Intermediate Farm Technology, Project Loan			X		Technological practices to improve farm production; FY 1977 slots $800,000 for commodities
Colombia	Training Grant No. 514-11-690-186, FY 1976 to FY 1977			X		Provides training for 10 Colombian participants in several areas including agriculture; trainees will then function as technical advisors
Colombia	Research on Hemoprotozoal Diseases of Food-Producing Livestock in LDC's Texas A&M University (csd-1947)				X	Cost July 31, 1973, $1,037,731; total cost, $2,688,000; development of a drug imparting resistance
Costa Rica	Title Not Available (1971-1978)	X				Pesticides purchased locally from AID-financed agricultural loans to improve grain production; historical uses have included aldrin, chlordane, other insecticides, fungicides, and herbicides
Dominican Republic	Agriculture Section Development, Grant No. 517-11-140-113, FY 1974 to FY 1978			X		Technical advisory assistance for several areas including agricultural technology

Table 32 (Continued): Currently Identified Food Production and Preservation Programs in Latin America

Country	Project/Program	Program Element[a] P.A.	O.P.	T/TA	R.	Comments
Ecuador	Title Not Available (1976-1977)	X				Pesticides purchased locally from AID-financed loan to promote short cycle oil crops and cacao (< $144,000) equipment and laboratory facilities for agriculture research including pests management (total $220,000)
	Title Not Available (1976-1977)				X	
El Salvador	Intensive Small Farm Management, Grant No. 519-11-110-174, FY 1976 to FY 1978			X		Provides agriculture technical advisors; multiple cropping to improve production
El Salvador	Title Not Available (1976)	X			X	Pesticides financed by El Salvador Ministry of Agriculture for AID-supported intensive cropping demonstration
Guatemala	Food Productivity and Nutritional Improvement, Grant No. 520-11-130-232, FY 1975 to FY 1979	b/		X		Technical assistance to increase food production; demonstrations may use pesticides
Guatemala	Title Not Available (1976)	X				Some pesticides to be purchased locally through AID production credit of $1.6 million; technicians AID-financed to implement new technology including pesticides for grains and vegetables; most common are organophosphates and carbamates
	Title Not Available (1971-1978)	X		X	X	
Guyana	Food Crops Technical Advisory Services (No Number), FY 1976 to FY 1978			X		Technical assistance to increase food crop production; may involve advice on pesticides
Guyana	Title Not Available (1976-1978)	X				Pesticides to be purchased from AID-financed agriculture food crop loan
Haiti	Rural Community Development, Grant No. 521-15-810-061, FY 1966 to FY 1978			X		Technical assistance from agronomists
Haiti	Agricultural Development Support, Grant No. 521-15-190-069, FY 1973 to FY 1977	b/		X		Technical assistance in corn production and rice seed multiplication; field testing could involve pesticides

Table 32 (Continued): Currently Identified Food Production and Preservation Programs in Latin America

Country	Project/Program	Program Element[a] P.A.	O.P.	T/TA	R.	Comments
Haiti	Nutrition Improvement, Grant No. 521-11-560-075, FY 1976 to FY 1980			X		Technical assistance to increase production of nutritious crops; FY 1977 commodities include agricultural supplies but no pesticides
Haiti	Integrated Agricultural Development, Grant No. 521-15-190-078			X		Technical assistance and supplies for irrigation system development; project will provide technical assistance for agricultural research
Haiti	Special Development Activities, Grant No. 521-15-998-062, FY 1968 to Continuing			X		Technical assistance to increase agricultural production
Honduras	Small Farmer Technologies, Grant No. 522-15-190-123, TQ to FY 1979	b/		X		Technical assistance in areas of agricultural economics and engineering; project provides for loans which may be used to purchase agricultural inputs, including pesticides, through AID-financed agricultural credit projects (total $430,800, 1971 to 1975, and $436,100, 1976 to 1978)
Honduras	Agro-Industrial Export Development, Grant No. 522-15-290-120, TZ to FY 1979			X		Technical assistance in agricultural production
Honduras	Title Not Available (1976-1978	X			X	Pesticides to be purchased by the Government of Honduras for field demonstrations in AID-financed agricultural credit projects (annual amount, $2,727)
Nicaragua	Title Not Available (1976-1978)	X				Estimated 51,600 lb and 117,000 gal. of pesticides including the insecticides parathion, carbaryl, trichlorfon, oxydemeton-methyl, and monocrotophos, and the herbicides atrazine, cyanazine, linuron, and alachlor to be purchased locally from AID-financed loan for small farmer integrated agricultural production program
Panama	Agricultural Development Support, Grant No. 525-15-190-182, FY 1977 to FY 1979			X		Funds to supply three technicians per each of the following areas: agronomy-perennial crops; livestock production; agricultural industry

Table 32 (Concluded): Currently Identified Food Production and Preservation Programs in Latin America

Country	Project/Program	Program Element[a] P.A.	O.P.	T/TA	R.	Comments
Panama	Integrated Rural Development Project Loan, FY 1977	b/				Provides agricultural credit programs; will finance purchase of pesticides locally; loans will later be provided for control of stored grain insects and vegetable diseases
Uruguay	Agricultural Research/Technical Assistance, Loan No. 528-T-024	b/				Loan authorized by May 13, 1975, $4,850,000; provides technical assistance and training in entomology and plant pathology through AID loan (does not include pesticide procurement)
Uruguay	Title Not Available (1976-1978)		X	X		Long- and short-term technical assistance (expert advisors) in the control of pests and diseases of fruits and vegetables and of noxious birds causing serious damage to field crops; control methods recommended by these advisors include chemical and nonchemical control methods
Caribbean Regional	Food Crop Production, Grant No. 538-11-130-007, FY 1976 to 1979	b/		X	X	Provides loans and advisors for research and to increase food production
Central America Regional	Small Farm Cropping Systems, Grant No. 596-11-140-064, FY 1975 to 1978				X	Research trials to determine optimal cropping systems
Colombia, El Salvador, Ecuador	Control of weeds in LDC's Oregon State University (csd-1441) (RES 130 463)				X	Cost December 31, 1972, $1,595,536; total cost, $3,128,514
Brazil, Colombia, Chile, El Salvador, Ecuador	Water Management Research in Arid and Subhumid Lands of the LDC's FY 1973 to 1977 Utah State University (csd-2167)				X	Cost March 31, 1973, $1,874,071; total cost, $4,889,071; may not require pesticide usage

Note: X = Anticipated activity

a/ P.A. = Pesticide activity
O.P. = Other pest management activities not involving pesticide activity
T/TA = Training/technical assistance
R = Research

b/ Possible activity

Proposed funding for the FY 1977 food and nutrition program in Latin America is $107.1 million. This represents a decrease of 27% from FY 1973 funding of $147.2 million largely due to the phasing out of Colombia and Brazil from AID programs.

The difference in emphasis on program goals has had the effect of relegating pest management activities to a position of minor importance in the overall program activities. Continuing technical assistance and training activities constitute the major share of AID's pest management activities. Also of importance is the increased emphasis on institutional factors affecting the availability of agricultural inputs to small farmers, which has the indirect effect of increasing the availability and use of pesticides in addition to other inputs. There is also considerable attention given to improving yields of most basic food crops; this includes a pest management component and some use of pesticides.

Pesticide Activities--

AID pesticide activities in Latin America are concentrated in the area of agricultural production credit loans which are used to finance local procurement of pesticides (see Table 32). The trend toward emphasizing institutional and economic factors affecting production in Latin America has had the effect of shifting activities from direct procurement and provision of agricultural inputs to the financing of loans used for production inputs by local farmers. Potentially, considerable quantities of pesticides could be procured in this manner, but exact quantities are unknown. Other AID-sponsored pesticide activities are for small quantities used in research and demonstration projects, and other training activities.

Suspended or cancelled pesticides--No pesticides for which the registration for use in the United States has been finally suspended or cancelled are planned for use in currently identified food production and preservation programs in Latin America.

Pesticides to be used in agricultural programs are not determined at the time a project is proposed for funding, but are selected prior to the implementation of a project on the basis of need, availability, and eligibility with respect to AID policy and regulations affecting the use of various pesticides. For this reason, specific pesticides have not yet been identified for use in FY 1977 proposed projects. In addition, AID has limited direct control of accounting procedures for pesticides procured through AID-financed agricultural credit loans, which constitutes the major area of AID pesticide activities for food production and preservation in Latin America.

AID pesticide activities in Latin America in the past have involved the use of aldrin and chlordane (see Appendix B). These pesticides were used prior to the suspension of their registrations, and no further use of these pesticides is planned for AID-financed food production and preservation programs.

Related pesticides--No pesticides chemically related to any suspended or cancelled pesticides are currently used or designated for use in AID food production and preservation programs in Latin America.

All other pesticides--Other pesticides that have been used in previous years on food crops in Latin America, purchased locally using AID-financed agricultural credit loans or provided directly by AID, include the insecticides parathion, carbaryl, trichlorfon, oxydemeton-methyl, and monocrotophos; and the herbicides atrazine, cyanazine, linuron, and alachlor. Pesticides to be used in FY 1977 projects have not yet been determined. Any pesticides provided by AID for demonstration, training, or other projects will be limited to those eligible under AID regulations. Pesticides purchased locally through AID-financed agricultural credit loans, however, are not directly controlled by AID.

Other Pest Management Activities--

A number of projects have pest management implications, even though pest control is not the primary objective of the project. Construction of storage facilities for food crops, for example, reduces losses caused by pests. Projects of this type are not included in the discussion. Pest management projects not involving the use of pesticides include nonchemical methods of controlling noxious birds (methods not specified) and a research project that involves nonchemical methods of disease and insect control for beans and cowpeas.

Technical Assistance and Training--

As in Africa, training and technical assistance in the area of food production and preservation is also the thrust of AID's pest management program in Latin America. Of 21 projects in Latin America with pest management components, 17 involve training or technical assistance.

Technical assistance is provided in all aspects of agricultural production with the objective of improving the capability of LDC's to increase agricultural production. This includes technical assistance in pest management, which involves improved cultural practices, introduction of resistant plant varieties, nonchemical methods of pest control, and expertise in the use and handling of pesticides. Technical assistance in the use and handling of pesticides is valuable, given that pesticide use would occur even in the absence of any United States involvement, and technical expertise on timing and rates of application and proper storage and handling can minimize adverse environmental and health effects while maximizing pest control effectiveness.

Training activities in pest management are designed to enable less developed countries to establish and maintain quality plant protection systems. Training consists primarily of educating individuals from LDC's in modern pest control methods and the safe handling and use of pesticides,

with the intent of developing an effective in-country pest control capability.

Research--

The primary objective of most research activities supported by AID is to increase agricultural production in the LDC's. Research activities relating to pest management in Latin America are designed to investigate methods of more effectively dealing with crop losses due to pests. This includes activities ranging from research into the characteristics and life cycles of certain pests to determining economically effective ways of controlling weeds in poor rural areas with high unemployment. A large portion of research activity is directed toward improving the effectiveness of pest control techniques under country-specific environmental, economic, and social conditions. Other research activities are directed toward implementing new technology and disseminating information.

Asia (21,22)

A total of eight Asian countries receive development assistance from AID. Total proposed funding for Asia in FY 1977 is $335.8 million, of which 68% or $227.3 million is designated for the food and nutrition program. This represents a decrease from the estimated FY 1976 funding level of $240.9 million and is partially balanced by an increase in proposed funding for population planning and health programs. (Figure 8 shows the Asian countries scheduled for any type of development assistance in FY 1977.)

The objective of AID food and nutrition programs in Asia is to establish a favorable balance between food supply and food requirements in aid-recipient countries (see Table 33). To achieve this objective, AID assistance is directed toward benefiting the small and medium-scale farmers with projects to increase agricultural production and to improve methods for storing and handling. Inherent in food production and preservation activities are methods or efforts to reduce losses to pests. However, AID's pest management activities in food production and preservation in Asia are minor in comparison to Africa or Latin America, and consist primarily of technical assistance or training.

Pesticide Activities--

The only pesticides programmed for use in currently identified projects are small amounts to be used in research and training activities in Bangladesh and the Philippines. In the Philippines, pesticides will be used at the National Crop Protection Center established at the University of the Philippines at Los Banos and seven regional crop protection centers. The scale of pesticide activities will be small and confined to use on a total of about 100 ha at the eight centers. Use of the pesticides will be for research and training under controlled experimental conditions monitored by experts.

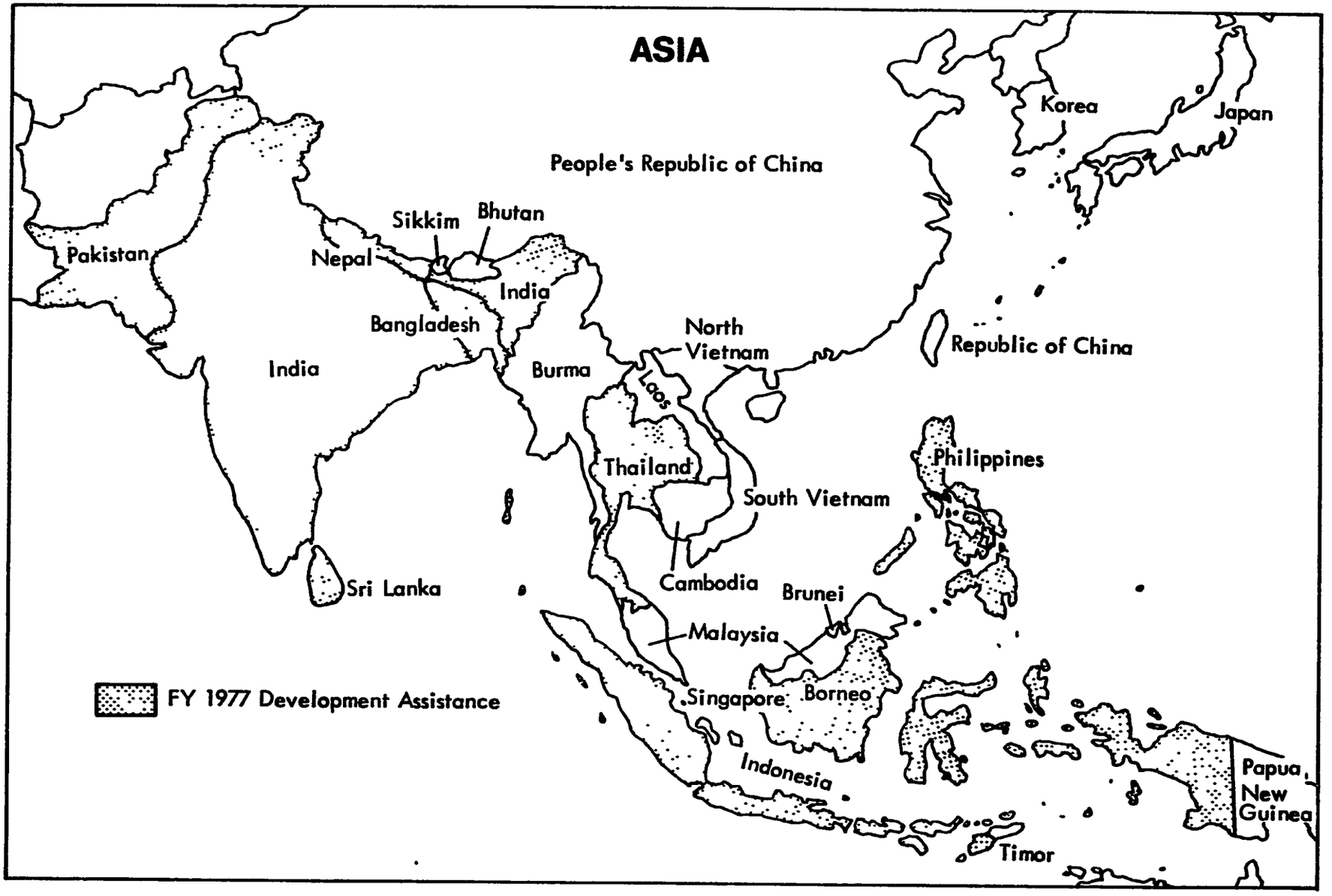


Figure 8 - FY 1977 Development Assistance in Asia

Table 33: Currently Identified Food Production and Preservation Programs in Asia

Country	Project/Program	Program Element a/ P.A.	O.P.	T/TA	R.	Comments
Bangladesh	Agricultural Research, Grant No. 388-11-110-003	b/		X	X	Research, technical assistance, small amount of pesticides used in research and demonstration; activities not yet specified
Pakistan	Agriculture Research				X	No specific mention of pest management
Philippines	Small Farmer Income and Production, Grant No. 492-55-130-259			X		Pesticides mentioned as previous program activity; not mentioned as part of FY 1977 program; probably training and technical assistance
Philippines	Pest Control			X	X	Research and test methods of pest control, including chemical; provide technical assistance to extension staff and training and transport field workers will be provided
Thailand	Agriculture Extension Outreach (Loan - No Number)			X		No specific mention of pest management; probably technical assistance and training
Thailand	Lam Nam Oon On - Farm Development (Loan - No Number)			X		No specific mention of pest management; probably training and technical assistance in nonpesticide categories of pest management and improved cultivation

Note: X = Anticipated activity
a/ P.A. = Pesticide activity
O.P. = Other pest management activities not involving pesticide activity
T/TA = Training/technical assistance
R = Research
b/ Possible activity

The specific pesticides to be used in Bangladesh and the Philippines are not defined at this time. However, pesticides to be used in research and demonstration projects will not include any pesticides for which the registration for use in the United States has been finally suspended or cancelled, or any chemically related pesticides.

Other Pest Management Activities--

A number of food production and preservation programs have pest management implications, even though reduction of losses from pests is not the primary objective. An example of this type of project is the construction of storage facilities for food crops. Projects of this nature will not be discussed in this report.

There are no currently identified projects that involve activities that can be defined as other pest management activities.

Technical Assistance and Training--

Five of six FY 1977 food production and preservation projects in Asia having pest management components involve technical assistance or training. Pest management activities in three of the five projects are limited exclusively to technical assistance or training.

The objective of technical assistance or training activities is to provide expertise in the most efficient methods of pest management available, and on the proper use and handling of pesticides to enable aid-recipient countries to establish effective self-maintained and self-staffed plant protection systems.

The proposed pest management project in the Philippines provides a good example of the training and technical assistance activities in which AID will participate in Asia. The project will provide "start-up" support of the National Crop Protection Center at the University of the Philippines at Los Banos and seven Regional Crop Protection Centers to help make these centers operational. AID assistance, as a reimbursable loan, will involve technical support, participant training, in-country manpower training, and financing for field and laboratory equipment. A minimum of 5 years will be required for completion of AID assistance, which is scheduled to end in 1981.

In essential specialty areas of pest management, where there is an inadequate pool of skilled, local personnel, AID will provide technical assistance until nationals have been trained in these areas. It is anticipated that short-term technical assistance will be necessary in some highly skilled specialities, such as may be needed for the establishment of an environmental and human safety laboratory, on-site training and assistance in the installation, use and maintenance of some specialized equipment, assistance in the development of some advanced training and extension programs. and short-term support for assistance in designing and conducting sociological and environmental impact studies and evaluating diffusion systems.

In specialties where some skilled personnel are available in the country, but where the total available resource is marginal and continued reliance on presently trained personnel by the Centers could strain country efforts in other programs, AID will provide assistance through participant training. This training will emphasize the Ph.D. level, where manpower shortages are most critical, and will be provided in specialties essential to the activities of the project and for which training is not currently available in the Philippines. Under the participant training program, trainees will be sent to appropriate U.S. institutes for formal specialized academic course work leading to a Ph.D. degree in their respective disciplines. Theses will be conducted in the Philippines or the United States and will be directly related to the activities of the Center. Upon return, successful trainees will fill key positions in the National Crop Protection Center at the associate or senior staff levels.

To meet the need for research extension and training staff at the associate and assistant scientist levels in the National Crop Protection Center and the seven Regional Centers, AID will support in-country training programs at the M.S. level in pest management specialties where too few in-country persons are available. A total of 50 scientists would be trained in various pest management specialties according to the needs and priorities of the Centers.

The Centers' in-service training approach will be designed to encourage the rapid transfer of the latest crop protection technology to government and private sector technicians and to key farmers. At the same time, the planned training approach will provide for an efficient feedback mechanism to the Centers on pest development and crop protection needs throughout the nation. Such information will be helpful for establishing research priorities for the National and Regional Centers.

Field technicians from both the government and private sectors will attend short-term training programs conducted during 6 months of each year at the National Crop Protection Center and continuously at the seven Regional Centers. Plans provide for the training of at least 5,000 officers and key farmers in the latest pest management technology during the 4-year period of AID inputs into the training program. The programs will become an ongoing activity of the Centers under direct support of the Philippine government when AID inputs are terminated.

Through the use of trained extension officers, direct training of key farmers and model pest control systems, it is anticipated that at least 700,000, or approximately one-third of the country's 2.1 million cereal farmers, will have received training in current pest management technology by the end of AID's inputs to the program. Thereafter, the training activities of the Centers will be an ongoing activity under the direct support of the Philippine government.

If the National Crop Protection Center is to function as the major Philippine resource for manpower and research in pest management, and if the seven Regional Centers are to function effectively as research and training arms of the National Center, significant outlays will be needed for field and laboratory equipment. Although the Philippine government has committed funds for the operation of the Centers, it does not have sufficient resources to provide the equipment that is required if program objectives are to be met within a reasonable time frame. AID will assist in the procurement of necessary field and laboratory equipment as part of the loan for this project.

Research--

Research activities conducted by AID in Asian program countries are directed toward improving agricultural production under country-specific environmental, economic, and social conditions. Activities include research on the effectiveness of various methods of pest control, including pesticides, cultural practices to reduce pest losses, development of resistant plant species, research into the characteristics and life cycles of certain pests, and field testing of pesticide efficacy. Asian program countries also benefit from more general research projects supported by AID and based in the United States (see Chapter I, page 73).

In the Philippine project, research activities will be conducted on land assigned to the Centers, the amount ranging from 5 to about 16 ha. These are arable agricultural lands suitable for growing the major Philippine food crops. Research on pest management strategies for control of weeds, diseases, nematodes, insects, rodents and other pests will be conducted on these lands. Use of resistant varieties, cultural controls, biological controls, chemical pesticides and other tactics will be evaluated. More promising strategies will be evaluated on farms. Emphasis will be placed on the safe use of pesticides, avoidance of harmful environmental impacts and minimizing residues.

Near East (23)

Figure 9 shows the Near Eastern countries scheduled for any type of AID development assistance in FY 1977. AID is providing FY 1977 development assistance to Afghanistan, Yemen, Morocco, and Tunisia (see Table 34). However, projects in the food and nutrition program area with pest management activities affect only Morocco and the Yemen Arab Republic.

A number of additional projects in Near East countries are funded under Security Supporting Assistance programs (see Figure 10 and Table 35). These programs are designed to improve the economic prospects of countries where it is important for the United States security interests or the achievement of the United States foreign policy objectives (24).

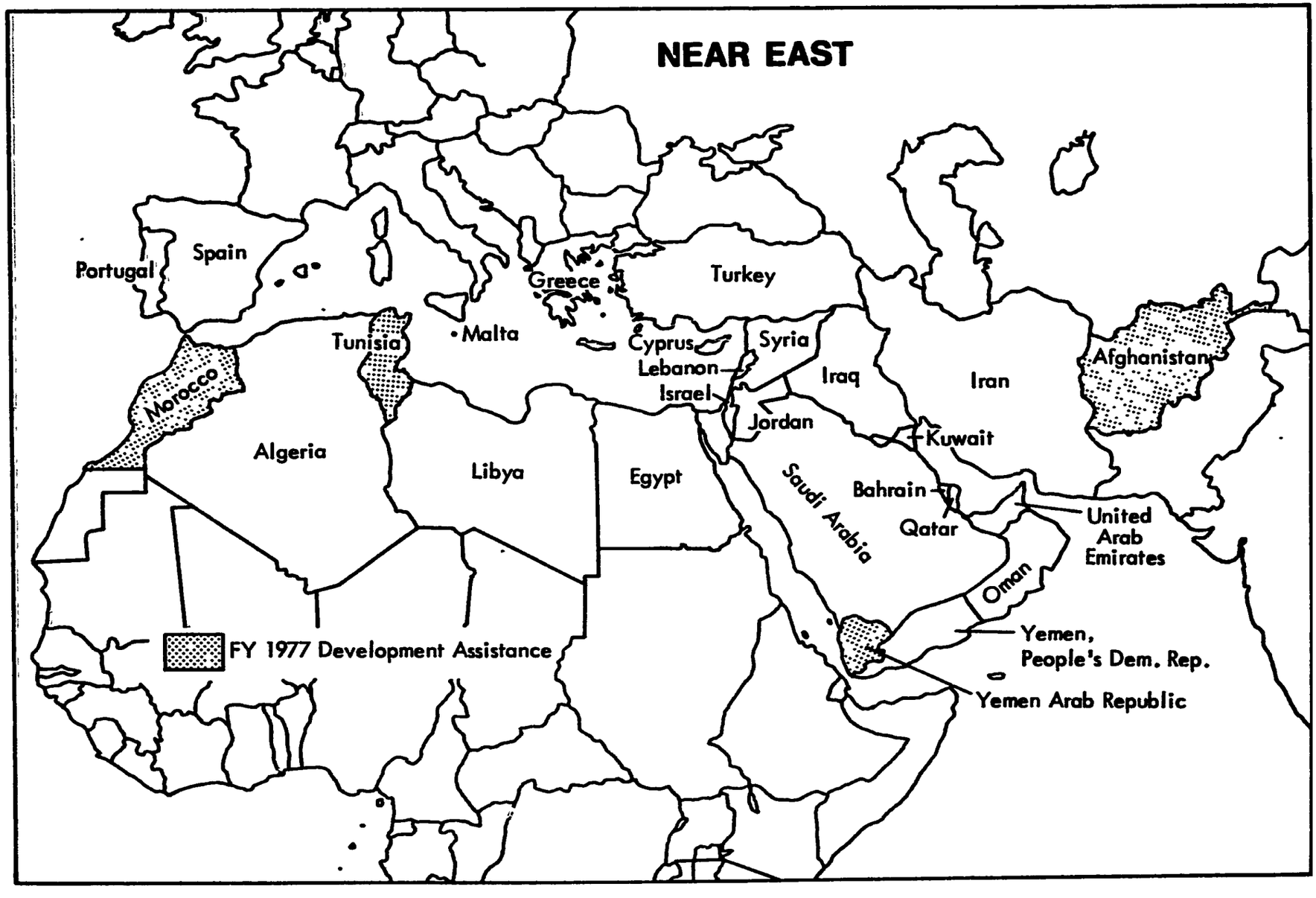


Figure 9 - FY 1977 Development Assistance in the Near East

Table 34: Currently Identified Food Production and Preservation Projects in the Near East

Country	Project/Program	Program Element a/ P.A.	O.P.	T/TA	R.	Comments
Yemen Arab Republic	Tropical and Subtropical Agriculture, Grant No. 279-11-130-024			?		No specific mention of pest management; probably technical assistance and training
Yemen Arab Republic	Agriculture Research and Development (Sorghum and Millet), Grant No. 279-11-110-030			X		No specific mention of pest management; increased agricultural productivity of sorghum and millet; training only
Morocco	Agriculture Research and Training, Grant No. 608-11-110-122			X		Training and technical assistance in plant pathology and entomology
Morocco	Dry Land Resource Development (Loan - No Number)	b/		X	X	No specific mention of pest management; "increase dry land agricultural production"; possibly research, technical assistance, and small amount of pesticides used for demonstration

Note: X = Anticipated activity

a/ P.A. = Pesticide activity
O.P. = Other pest management activities not involving pesticide activity
T/TA = Training/technical assistance
R = Research

b/ Possible activity

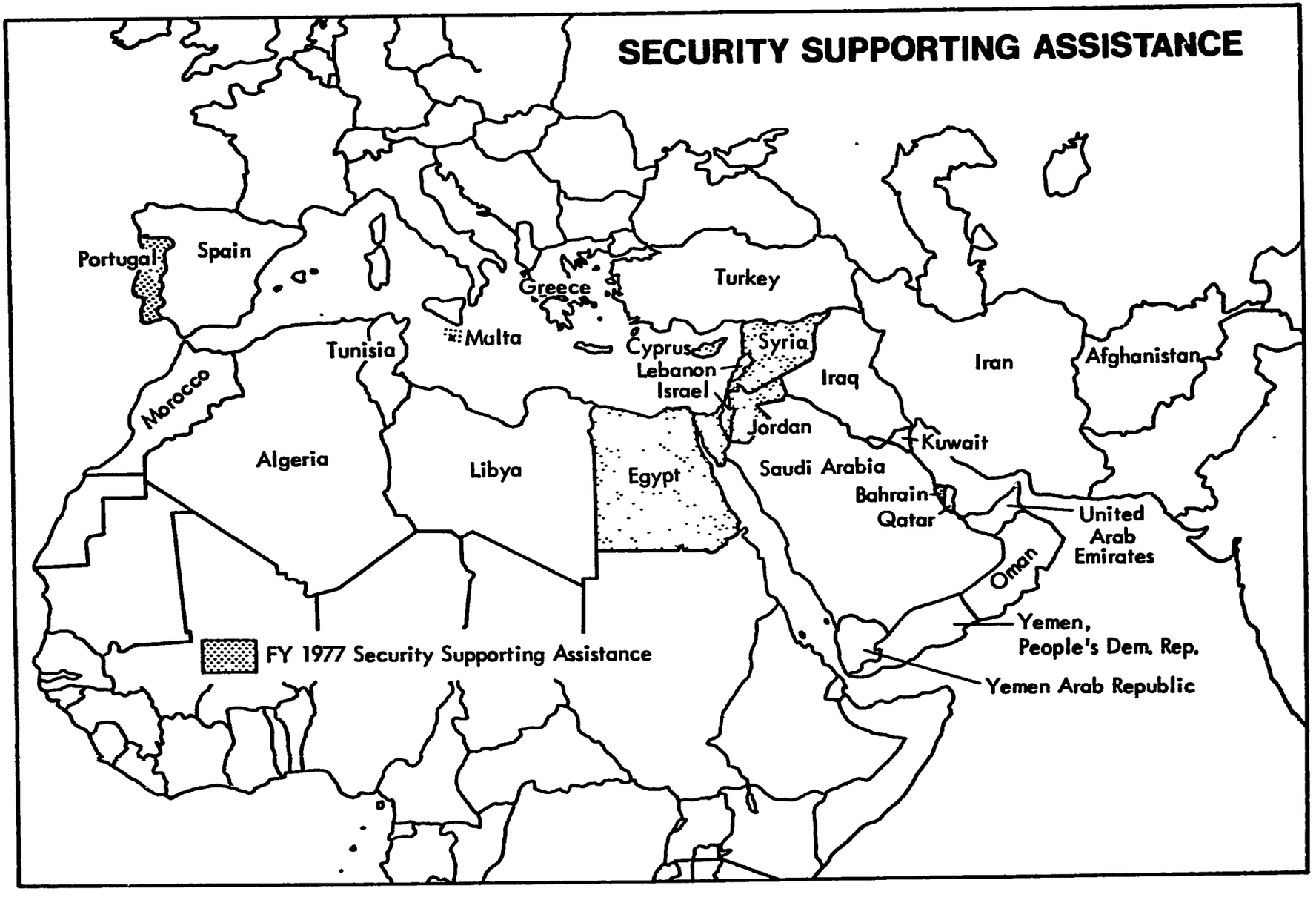


Figure 10 - FY 1977 Security Supporting Assistance

Table 35: Currently Identified Food Production and Preservation Projects for Security Supporting Assistance

Middle East Special Requirements Fund

Country	Project/Program	Program Element[a/] P.A.	O.P.	T/TA	R.	Comments
Egypt	Commodity Import Program III (Loan - No Number)	b/				Loan to procure "wide range of commodities needed by agricultural" sector; probably includes pesticides
Israel	Commodity Import Program (Program Loan - No Number)	b/				Loan to purchase commodities from abroad that included "chemical products" and "agricultural equipment"; possibly some pesticides
Jordan	Faculty of Agriculture Research and Development, Grant No. 278-11-110-178			X		Upgrade faculty to improve capability for agricultural research; probably includes pest management research
Jordan	Dry Land Cereal Production, Grant No. 278-11-110-184			X	X	Possibly training, technical assistance, and research in pest management methods; includes testing of cultural practices to improve production
Jordan	Technical Services and Feasibility Studies, Grant No. 278-15-995-181			X		Technical services to be provided in "agriculture and agrobusiness"
Jordan	Jordan Valley Agricultural Development, Grant No. 278-15-140-187			X	X	Technical assistance and training in disease control and plant protection problems resulting from intensive irrigated cropping
Syria	Agriculture Development (Research and Production), Grant No. 276-11-110-003	b/		X	X	Control of plant diseases and pests specifically stated; activities primarily limited to technical assistance, training, and research; some pesticides for demonstration
Syria	Feasibility Studies and Project Development - III, Grant No. 276-11-995-009			X		Technical assistance and training in agricultural sector; probably includes technical assistance and training in pest management

Note: X = Anticipated activity

a/ P.A. = Pesticide activity
O.P. = Other pest management activities not involving pesticide activity
T/TA = Training/technical assistance
R = Research

b/ Possible activity

A total of eight food and nutrition projects funded through this program for FY 1977 involve pest management activities. The projects affect four additional Near East countries; Egypt, Israel, Jordan, and Syria. The objectives of projects funded under Security Supporting Assistance programs differ from the objectives of normal AID activities in that benefits accrue to the entire economy of a program country, and are not focused on the rural poor or disadvantaged women in the country.

Pesticide Activities--

Pesticide activity has been identified in only one current or projected AID development assistance program in the Near East. A project in Morocco designed to increase agricultural production on dry land will probably involve the use of a small amount of pesticides for research and demonstration activities included under the project. No other pesticide activities are designated under current and projected programs.

Pesticide activity funded through projects under the Security Supporting Assistance program is more extensive. Three FY 1977 projects under the program involve the probable use of pesticides. One project in Syria potentially involves only a small amount of pesticide use in demonstration plots for technical assistance purposes. The two other projects with pesticide activities, however, are Commodity Import Programs (CIP's) in Egypt and Israel, and are potential sources of substantial pesticide procurements financed by AID. The CIP in Israel especially has been used in the past for the procurement of significant amounts of pesticides. AID-financed pesticide procurements for Israel in FY 1976 involved nine different active ingredients and are listed in Table 36. Most of the pesticides listed were procured through Israel's CIP. The list is dominated by the herbicide MSMA (181,454 kg active ingredient) and the insecticide malathion (51,933 kg active ingredient).

Egypt's CIP is a relatively new program, and no pesticide procurements were made in FY 1976 through March 1976. However, pesticide procurements could be anticipated in FY 1977 financed through Egypt's CIP.

Suspended or cancelled pesticides--There are no pesticides for which the registration for use in the United States has been finally suspended or cancelled that are designated for use in current or projected food production and preservation programs in the Near East.

Table 36: AID-Financed Pesticides for Israel--FY 1976

Active Ingredient	Kilograms (active ingredient basis)
Benomyl	2,000
DEET	3,280
Endrin	2,844
Malathion	51,933
Monocrotophos	37,631
MSMA	181,454
o-Phenylphenol	8,256
PCNB	5,098
Thiabendazole	6,609

Related pesticides--The chlorinated hydrocarbon endrin was procured for use in Israel in FY 1976. However, there are no anticipated uses of pesticides chemically related to cancelled or suspended active ingredients in Israel.

All other pesticides--As shown in Table 36, a total of nine different pesticides were procured through AID financing for use in Israel in FY 1976. The continuance of the CIP program in Israel and the addition of a CIP program in Egypt in FY 1977 would result in the potential continued procurement of pesticides for use in these two countries. The specific types and amounts of pesticides are not designated in a CIP program, however. The types and amounts of pesticides planned for use in demonstration and research projects in Morocco have not yet been determined, but will be limited to those eligible under AID policy and regulations.

Other Pest Management Activities--

There are no currently identified projects in the Near East that can be defined as other pest management activities.

Technical Assistance and Training--

The focus of AID's food production and preservation pest management activities in the Near East, as in other regions, is on technical assistance and training with the objective of enabling aid-recipient countries to develop an in-country pest management expertise and plant protection system. Of 12 FY 1977 food and nutrition projects with pest management activities funded for the Near East through Development Assistance or Security Supporting Assistance, 10 involve technical assistance or training. Both technical assistance and training are provided for all aspects of agriculture with the objective of improving yields of a number of different

crops under country-specific conditions. Included in these activities are technical assistance and training on cultural practices, control of plant diseases, and other aspects of pest management designed to reduce losses to pests. Perhaps the most important aspects of technical assistance and training activities are the expertise and guidance provided on the proper and efficient handling and use of pesticides to maximize production benefits of pesticide use while minimizing adverse environmental and health risks. Only the CIP's in Egypt and Israel and one research project in Pakistan provide pest management assistance that does not include some form of technical assistance or training.

Research--

Pest management activities in FY 1977 food and nutrition projects in the Near East include three projects with country-specific research activities. These projects are centered in Jordan and Syria and are designed to improve methods of reducing losses to pests under country-specific conditions. Near East countries also benefit from more general pest management research projects that are centered in the United States. (See Chapter I, page 73, for a more detailed review of research projects.)

PUBLIC HEALTH PROGRAMS

Health conditions and agricultural productivity are highly interrelated in the less developed countries. Nutritional improvements are necessary; diets contain low caloric levels and are generally deficient in protein, minerals, and vitamins, causing low disease resistance. Agricultural productivity also suffers from days lost because of illness. Rapid population growth in conjunction with low agricultural production intensifies poor health conditions. To resolve this spiraling problem, the AID approach to public health is multidirectional. The current and future emphasis of the AID public health programs is: first, to reduce population growth rates; second, to improve general health conditions by the delivery of health services to the poor; and third, to control endemic diseases.

Endemic diseases are of particular concern because they affect not only the overall level of health but also agricultural productivity by increasing workdays lost because of illness. The settlement and development of many potentially productive agricultural regions are prevented by the presence of endemic diseases. AID pest management activities in public health programs are limited to the control of vector-borne endemic diseases. Table 37 summarizes information on 15 vector-borne diseases endemic to regions receiving AID assistance. AID, however, funds research and control programs for only five of these diseases.

Table 37: Vector-Borne Diseases Endemic to Regions Receiving AID Assistance

Disease	Vector	Endemic Areas
Bartonellosis	Sandfly, genus Phlebotomus	Peru, Ecuador, Southwest Colombia
Chagas Disease	Retuviid bugs, family Reduviidae, and winged, blood sucking insects of Triatoma and Rhodnius	Central and South America
Dengue Fever	Mosquitoes, Aedes aegypti, A. albopictus, A. scutellaris	Southwest Pacific, Southeast Asia, Philippines, Indonesia, India, Pakistan, Caribbean Islands
Fasciolopsiasis	Intermediate hosts are snails of the genus Segementininae of the Planorbidae	Orient
Filariasis	Mosquitoes, Culex fatigans, C. pipiens, Aedes polynesiensis (pseudoscutellaris), Anopheles, Mansonia, and other Aedes	Latin America, Pacific Islands, Southeast Asia, India, Indonesia and other warm regions
Hemorrhagic Fevers	Mosquitoes, Aedes aegypti	Philippines and Southeast Asia during rainy season
Leishmaniasis (cutaneous and visceral)	Female sandflies, genus Phlebotomus	Northwest India, western Pakistan, Middle East, Northwest and Central Africa, Mexico, Central and South America (cutaneous not endemic to Chile)
Loiasis	Mangrove fly, genus Chrysops	Tropical West and Central Africa
Malaria[a/]	Mosquitoes, genus Anopheles	Tropical and subtropical Africa, Asia, Central and South America, and Southwest Pacific, and Near East
Onchocerciasis[a/]	Blackfly, genus Simulium	Guatemala, southern Mexico, northern Venezuela, Colombia, Africa from Sierra Leone south to Angola, eastward south of the Sahara through Zaire, Zambia, Malawi, Kenya, Uganda, Ethiopia and Sudan
Paragonimiasis	Intermediate hosts, snails of genera Semisulcospira, Thiara, crabs of genera Eriocheir and Potamon	Far East, Korea, Japan, Taiwan scattered foci in Philippines, China, southeast Asia, Africa, and South America
Schistosomiasis[a/]	Intermediate hosts, snails of genera Bulinus, Biomphalaria, and Oncomelania	Orient, Africa, Arabian peninsulas, eastern South America, Middle East, Caribbean area, small focus in India
Trypanosomiasis[a/]	Tsetse fly, Glossina palpalis, G. tachinoides, G. morsitans, G. pallidipes, G. swynnertoni, and G. fuscipes	Gambia, Liberia, Sierra Leone, Ghana, Zaire, Zambia, Rhodesia, Mozambique, Malawi, and Tanzania

Table 37 (Concluded): Vector-Borne Diseases Endemic to Regions Receiving AID Assistance

Disease	Vector	Endemic Areas
Typhus Fever	Bites of fleas or ticks	Worldwide
Yellow Fever[a/]	Mosquitoes, *Aedes aegypti*, *A. simpsoni*, *A. leucocelaenus*, and forest mosquitoes of the genus *Haemagogus*	West coast of Africa, south of the Sahara through Zaire, to Zambia, Botswana, Malawi, Uganda, Tanzania, Kenya, Ethiopia, Somalia, and Sudan in areas contiguous to rain forests

a/ AID funds received either for disease control or research.
Source: Adapted from Beneson, A. S., Edition 1970. *Control of Communicable Diseases in Man*, 11th Edition. The American Public Health Association, Washington, D.C. (25).

The funding of current and anticipated programs on vector-borne disease through the AID regional bureaus is discussed in the following subsections by geographical region. Many research programs are funded through an inter-regional environmental health program, but are conducted in a specific area; these projects are also discussed by region. Where available, the following discussions include data on probable pesticide usage.

Research activities not specific to region, including expanded studies on schistosomiasis control methods, research on new malaria control methods, and malaria immunity and vaccination research, are summarized in Table 38.

One proposed project not listed in Table 38 is of special note. This project would supply the resources needed to conduct a workshop on priorities in malaria research. AID has already provided more than 600 million dollars in support of malaria control/eradication programs in 36 developing countries, is currently supporting malaria control programs in four countries at a rate of approximately 16 million dollars per year, and is considering support of at least two additional programs. The total amount expended on malaria research by AID amounts to only a fraction of 1% of the total expended on malaria operations. At the present time AID is supporting malaria research at the level of about $1,400,000 per year, of which $1,250,000 is for development of a vaccine. This is long-range, high-risk, high payoff research which may well revolutionize the approach to malaria control. However, the large scale resurgence of malaria in large areas of the world is so serious now that new technology is urgently needed to cope with the immediate problem.

AID is proposing to conduct a workshop to establish comparative priorities for research and development of the various methods of malaria control, including malaria immunity and vaccination, chemotherapy, biological control (use of predators, pathogens, etc.), development of new insecticides, increasing the effectiveness of available insecticides, genetic control and source reduction. (See page 75 for a brief discussion of these control methods.)

The workshop would include scientists at the forefront of research in these various fields as listed above, directors of operational malaria and vector control programs at the national level, eminent scientists with a broad background of experience in tropical medicine in the less developed countries and representatives of concerned bilateral and international organizations.

The priority listing developed by this workshop would serve as a guide for future support of malaria research and would be of inestimable value to AID, NIH, U.S. Army, U.S. Navy, PAHO, and WHO.

Table 38: Interregional Public Health Programs

Country	Project/Program	Program Element[a/] P.A.	O.P.	T/TA	R.	Comments	Pesticide
Indonesia	Environmental Health Interregional, Grant No. 931-11-590-N13, possibly begun FY 1976	X			X	FY 1976: field evaluation of fenitrothion, malaria, and biodegradable DDT as DDT substitute in malaria programs in Indonesia	Fenitrothion--biodegradable DDT
See Comments				X		FY 1976: technical assistance to malaria program in Indonesia,[a/] Haiti, Pakistan, Sri Lanka, Zaire, Nepal, Ethiopia, Nicaragua, El Salvador, Guatemala, Honduras	
Tanzania and Ghana						FY 1976-1977: development of a model which determines the socioeconomic effects of schistosomiasis control methods; conducted in Africa	
					X	FY 1977: expand studies on schistosomiasis control	
					X	FY 1978: research on new malaria control methods	
Pakistan				X	X	FY 1977: increase research and training in control of six tropical diseases (including malaria, schistosomiasis, onchocerciasis and trypanosomiasis); done in cooperation with WHO in Pakistan	

Source: AID. Proposed Programs for 1977, Interregional and Personal Communication with AID, July 14, 1976.

a/ P.A. = Pesticide activity
O.P. = Other pest management activities not involving pesticide activity
T/TA = Training/technical assistance
R = Research

b/ Underline signifies on-site technical assistance; all other technical assistance is through AID/Washington.

Africa

AID's African public health programs place strong emphasis on limiting population growth rates to levels compatible with increases in productivity and on the establishment of rural health care services. In recent years the African population has increased at an annual rate of 2.7%, slightly above the average of the less developed countries as a whole. However, contraception programs are often difficult to conduct because of the rural nature of much of the African society and traditional views regarding family size. Consequently, AID's family planning assistance is provided within a general family health care program, i.e., preventive health care, maternal and child health, and nutritional improvement. These programs do not include pest management activities (17).

AID also proposes to fund endemic disease control programs in Africa to improve general health and well-being. Control of several of these endemic diseases is being accomplished through control of the insect vector, as discussed in the following subsections.

Pesticide Activities--

Of the currently identified public health programs for Africa, only three involve usage of pesticides.

AID funds malaria control projects as part of the Endemic Disease Control program in Zaire. Of the grant of $2.5 million, $1.5 million has been delegated to controlling endemic diseases and measles. Funding began in FY 1976 and is authorized through FY 1979. Usage of DDT against malaria vector mosquitoes is planned for FY 1977. The amount of DDT to be used, however, has not yet been determined (17,26).

Usage of DDT is also anticipated during a malaria control program in Ethiopia financed by a $7.2 million AID loan. The anticipated DDT requirement for FY's 1976 and 1977 is 2,000 MT. The DDT will be applied as a household spray to the interior walls or ceilings or to protected outer walls where it will not wash away. Losses of DDT during spray activities are anticipated to be minimal (26,27).

AID does not anticipate usage in Africa of pesticides related to suspended or cancelled chemicals.

Usage of organophosphate insecticides is anticipated in endemic disease control programs, i.e., onchocerciasis and malaria. AID and WHO are conducting an ongoing onchocerciasis control program in seven African countries (Benin, Ghana, Ivory Coast, Mali, Niger, Togo, and Upper Volta). Blindness incidence is approximately 5% of the population in this region. AID funding began May 1974, and to date is $3 million. Specific AID activities anticipated through FY 1978 have not yet been determined (26). However, activities proposed at the program's inception include weekly larviciding of fly breeding areas (17) with Abate®.

AID anticipates usage of two organophosphates, malathion and Abate®, for malaria control in Zaire. Larviciding of mosquito breeding areas with Abate® is being currently done. Data on amounts of Abate® applied are not available (26). Control of adult mosquitoes is anticipated to require some malathion, but primarily DDT as previously discussed. Amounts of malathion that may be required have not been determined (17).

Limited amounts of malathion also may be procured in FY 1977 for usage against malaria in Ethiopia (26), but the potential quantity is not known.

Other Pest Management Activities--

AID finances research on tsetse fly control in Tanzania involving the sterile-male release technique. This program proposes control of tsetse fly populations by releasing sterile males that subsequently mate unproductively with the indigenous female population. Aerial spraying of tsetse fly infested areas is being considered but no decisions have been made on whether spraying will be done or the pesticide of choice. Reducing tsetse fly populations will lead to reduced incidence of African sleeping sickness (trypanosomiasis) (28).

Technical Assistance and Training--

AID provides technical assistance to African public health programs through on-site and Washington personnel. Zaire receives technical assistance on its malaria control program through funds supplied by their endemic disease control grant (17,26). Ethiopia also receives technical assistance on malaria control through AID; funding is provided by the interregional environmental health program (17).

Extensive technical assistance is provided to the previously discussed onchocerciasis control program in the Sahel, West, and Central African regions. AID will provide an on-site advisory team, flight crews, epidemiologist, entomologists, and other necessary assistance (17,26).

Training programs are to be conducted under only one project: Malaria Control Loan Phase V, Ethiopia. Personnel will be retrained in control methods for a wide spectrum of communicable diseases (27). Benefits of training programs will be threefold: (a) personnel will learn proper usage and application techniques for pesticides; (b) transmission of disabling diseases will be decreased; and (c) pretrained personnel will aid in integrating malaria control into the basic health services program of Ethiopia.

A history of technical assistance and training activities supplied to African countries is discussed in Chapter I.

A proposed program of particular importance is the self-help program for malaria control in Africa. This program would involve field trials of a number of malaria control techniques, including physical barriers between mosquitoes and the population at risk, water management, antimalaria drugs, larvivorous fish, use of repellent sprays, dry season larvicidal control, and health education. These trials would be conducted on a community basis in Tanzania where self-help is already the officially adopted method of the governments and in Nigeria in cooperation with the WHO-Nigerian government cooperative program. This program would be conducted through WHO.

Research--

AID has financed a research project in Kenya to develop methods of genetic control of the mosquito Aedes aegypti, a vector of yellow fever. This program was conducted by the University of Notre Dame through AID funds. Funding ended in December 1975; a program extension request has been filed but has not yet been approved (17,26). Future AID projects, research, and other pest management activites may include the extension of this project.

The malaria control program in Ethiopia involves three research activities. Future activities include an investigation of alternative mosquito control methods. Second, the program will study susceptibility and resistance of mosquitoes to insecticides. Finally, malaria incidence will be monitored through epidemiology studies.

Epidemiological study of onchocerciasis incidence plus research on parasites, larvacides, and antionchocerciasis drugs are funded for FY's 1974 through 1979 by the onchocerciasis control program in the Sahel, West, and Central African regions.

The effects of various schistosomiasis control techniques are being investigated in Tanzania and Ghana. Funding of this program began in FY 1976 as part of an interregional environmental health program (17).

A study of schistosomiasis control in areas freed of onchocerciasis transmission is anticipated for the Sahel, Central, and West African regions. At present, however, details on this proposed program have not been developed (17). (See Chapter I, page 74 for a more detailed review of health research projects.)

A summary of the currently identified public health AID programs in Africa is presented in Table 39.

Latin America

Population problems are a major deterrent to economic growth in Latin America. The population of Central and South America increases by an average of 2.6% annually, resulting in a high percentage of the population being under 15 years of age. Consequently, a high percentage of the population is not economically productive. Rising living standards, and improved sanitation, health, and nutrition have greatly reduced mortality and have, thereby, intensified population burdens.

Currently identified AID programs are focused primarily on attacking and solving Latin American population problems. The major portion of the FY 1977 proposed health budget will fund family planning and contraception programs. Proposed AID funding of family planning programs is $7.1 million allocated to 12 countries.

Of next priority is the development and implementation of low-cost, rural health delivery systems. Included will be training of paramedics and supplying information on health and nutrition. Control of endemic diseases will receive less emphasis (e.g., malaria) (20).

Discussed in the following sections are the proposed AID loans and grants financing public health programs involving pest management; only two countries are involved in pest management activities. All other AID-financed public health programs (67% of total population and public health FY 1977 funding) deal with population control, family planning, and low-cost rural health delivery systems. These programs do not involve pesticide activity or any other form of pest management.

Pesticide Activities--

Three of the pest management programs authorized for Latin America propose usage of pesticides. These programs plan pesticide applications to control malaria and will be conducted in Haiti and possibly Colombia.

Table 39: AID Public Health Programs for Africa

Country	Project/Program	Program Element[a/] P.A.	O.P.	T/TA	R.	Comments	Pesticide
Ethiopia	Malaria Control Program Phase V - active loan No. 663-U-025 authorized 5/31/75	X		X		Procurement of insecticides for malaria vector control Technical assistance through Washington	1975: 2.6 million kg (5.8 million lb) of DDT FY 76/77: 2,000 MT DDT Possibly small amounts of malathion
Zaire	Endemic Disease Control Grant No. 660-11-510-058 FY 1976 to FY 1979			X		Establish a model malaria control program (other aspect of program deals with measles); training some personnel	Abate®, 2,4-D, DDT malathion
		X				FY 1977: $200,000 allotted to purchase of spray equipment and supplies, medicine, etc. Will involve use of pesticides for malaria	
				X		FY 1977: technical assistance to be included	
Sahel, Central, West Africa Programs	Regional Onchocerciasis - Free area planning, Grant No. 625-11-190-912, FY 1976 to FY 1977				X	FY 1977: one area to be investigated with requesting funds involves public health; a study will be made on measures to control bilharzia (schistosomiasis) in the areas freed of onchocerciasis transmission	-
Sahel, Central, West Africa Programs	Onchocerciasis Control, Grant No. 625-11-510-908 FY 1974 to FY 1979	X				Program calls for monthly treatments of fly breeding areas with larvacides	Abate®; possibly chlorphoxim or methyl-Dursban®
					X	Continuous epidemiological studies; research on the parasites, on larvacides, and on onchocerciasis drugs	
				X		Training program for workers	

The Haitian Service National d'Eradication of Malaria (SNEM) currently procures and anticipates future requirements for DDT in a Haiti health services program (see Table 40). Approximately 75% of all sickness in Haiti is due to endemic and communicable diseases. Projected DDT usage will be directed toward control of the malaria vector, mosquitoes of the genus Anopheles (10). Total amount of DDT required in 1975 was 118 MT; projected requirements for 1976 are 80 MT, and for 1977 are 40 to 60 MT. The DDT will be applied as a residual spray on the walls and ceilings of rural homes. As vector susceptibility decreases, amounts of DDT required for house-spraying are expected to decrease as indicated by decreases in anticipated DDT procurements (10).

No use of pesticides chemically related to suspended or cancelled pesticides is anticipated in AID's Latin American public health programs.

The Haiti health service program previously discussed also proposes usage of the organophosphate insecticide malathion. Malaria vector mosquitoes have shown increasing resistance to DDT and other chlorinated hydrocarbons, necessitating use of pesticides from other chemical classes. Thus far, the organophosphates and carbamates have been sufficiently effective in controlling Anopheles mosquitoes (10).

AID procured a total of 18,900 liters (5,000 gal.) of 96% malathion for use against malaria vectors from 1972 to 1976. No data are available on future malathion requirements (10).

Other Pest Management Activities--

Other pest management activities achieve pest control without usage of pesticides. One AID project in Haiti plans to reduce malarial incidence by reducing Anopheles breeding areas (10). This objective will be achieved through water management techniques. However, the specific management techniques have not yet been determined for the Haiti project. Water management techniques may include draining of swamps or other standing water or improved irrigation techniques.

Technical Assistance and Training--

The goal of many AID public health programs is to assist in the development of a malaria program, and integration of this program into the health services structure of the recipient country. Programs proposed for FY 1977 in Bolivia and Haiti will provide both technical assistance and training for malaria control.

An ongoing rural health services delivery program in Bolivia is scheduled for completion in FY 1979. One aspect of this program is control of endemic diseases--in particular, malaria. Anticipated AID activity in FY 1977 will be technical assistance to Bolivian personnel during inception

Table 40: AID Public Health Programs for Latin America

Country	Project/Program	Program Element a/ P.A.	O.P.	T/TA	R.	Comments	Pesticide
Bolivia	Rural Health Services Delivery, Grant No. 511-11-590-453, FY 1976 to FY 1979			X		One aspect of the project is to reduce the incidence of endemic diseases; malaria will be attacked; FY 1977 program is technical assistance in establishing approach plans; project may later include pesticide usage	-
Colombia	Health Sector II, Loan No. 514-U-075, FY 1975	X				Multidirectional health program which may involve some pesticide use to control malaria vectors	-
Haiti	Strengthening of Health Services, Grant No. 521-11-510-070, FY 1974 to FY 1977	X	X	X		FY 1977: propose training of participants in water management to reduce malaria by reducing breeding areas; supplying anti-malaria drugs	DDT, Malathion, Propoxur
				X		FY 1977: participant training for malaria vector control	
				X		FY 1976: concentrated on malaria epidemiology studies	
Haiti	Strengthening of Health Services II, Grant No. 521-11-510-086, FY 1977 to FY 1981			X		FY 1977: providing malariology programs for trainees	-
Haiti	Strengthening of Health Services II, Project Loan, FY 1977	X		X		Training of malaria control workers; future project activities will involve pesticide usage	-

Note: X = Anticipated activity

a/ P.A. = Pesticide activity
O.P. = Other pest management activities not involving pesticide activity
T/TA = Training/technical assistance
R = Research

and formation of their malaria control program. Implementation of the control program may require pesticide usage (DDT, malathion, or propoxur). However, it has not yet been determined whether or when such pesticide inputs will be required, or whether they will be AID-procured (20).

AID technical assistance and training services will be provided to Haiti. Senior level assistance will be used to evaluate and organize the malaria control effort. Short-term consultants will also be available for general administration and epidemiological studies. In addition, AID will finance 8 person-years of training for two medical officers, an entomologist/parasitologist, and epidemiologist at the master's degree level (10). Additional technical assistance services will be provided to El Salvador, Guatemala, Honduras, and Nicaragua through the AID Washington office as part of an interregional public health program (20).

Research--

A malaria epidemiology study is being conducted in Haiti preliminary to the pesticide activities and training programs scheduled for FY 1977; malaria epidemiology studies are also in progress in El Salvador.

AID has under consideration support of a research proposal for combined genetic and biological control of Anopheles albimanus in El Salvador to be conducted by Gainesville Laboratory of the U.S. Department of Agriculture.

Table 40, page 168, presents a summary of currently identified AID public health programs in Latin America which involve pest management.

Asia

AID public health policy in Asia attacks two major problems: (a) population growth rate; and (b) general health conditions (21). Curbing population growth is approached three ways. First, AID will fund delivery of family planning, maternal health, and child health information. Second, assistance will supply contraceptives. Finally, AID will provide demographic information enabling recipient countries to formulate a population planning program. These programs do not involve pest management activities.

To improve general health conditions, AID funds malaria and other communicable disease control programs. More AID malaria control programs are conducted in Asia than in any other region of the world. The antimalaria programs are the only public health projects in Asia involving pest management. Pest management activities currently conducted and proposed in these programs are discussed in the following subsections.

Pesticide Activities--

Three of the four malaria control programs in Asia are currently using or anticipate usage of DDT against the vector mosquitoes (genus Anopheles). A $5 million grant to Nepal for FY's 1976 to 1979 appropriates funds for the purchase of DDT. A total of $1.9 million (jointly financed by AID, the

Government of Nepal, UNDP, and the WHO) was authorized for FY 1976, $2.1 million for FY 1977, and $2.4 million for FY 1978 for procurement of DDT for Nepal's malaria control program (21,13).

Purchase of pesticides for Pakistan will be financed through a $35 million malaria control loan. The project's goal is to reduce annual DDT requirements to 150 MT by 1978 to 1979. Average annual DDT usage for FY's 1975 through 1977 is anticipated to be about 1,200 MT (14).

DDT purchase for malaria control in Indonesia is also financed through an AID loan. Indoor spraying of domiciles uses 75% active ingredient wettable powder DDT at an application rate of 2 g/sq m. Current and anticipated DDT procurements (by areas of Indonesia) over the 5-year project are summarized below (21,30).

FY	Total DDT (MT)	Java, Bali, and Madura	Outer Islands
1975	5,300	4,900	400
1976	3,750	3,250	500
1977	3,750	3,250	500
1978	3,000	2,250	750
1979	3,000	2,000	1,000

AID loans for malaria control also finance acquisition of pesticides related to the cancelled insecticide DDT. Application of another organochlorine, BHC, is financed in Pakistan's malaria control program. Originally, spraying of the interior walls of homes with BHC was anticipated to average 30 MT annually for FY's 1975 through 1977. Malaria control was anticipated to reduce the annual requirement of BHC to 4 MT by FY 1979 (14). However this program is currently being redefined and the treatment areas and methods are being reevaluated.

With the development of vector resistance to chlorinated hydrocarbons, the organophosphate insecticides have supplemented or replaced DDT and BHC usage for malaria control. In the Indonesian malaria control program, mosquito resistance to DDT has become a problem in central Java. An anticipated 0.45 MT (990 lb) malathion will be applied in experimental areas during the 5-year period of the program (26,30).

Malathion is the insecticide of choice in Pakistan's malaria program. Average annual application for FY's 1975 to 1977 is estimated at 7,100 MT (14).

Subsequent estimates are 21,423 MT for FY's 1976 to 1978 (26). Malaria control is expected to reduce annual malathion requirements to 800 MT by FY 1979. (See page 226 for a discussion of the recent problems experienced in Pakistan with malathion.)

Usage of malathion will be required in a malaria program anticipated in Sri Lanka. A 5-year, $17.5 million malaria control loan is pending. Authorization would allot $4.9 million for malathion procurement (26,21).

Other Pest Management Activities--

AID does not currently fund and does not anticipate funding (through FY 1978) other pest management activities in Asia.

Technical Assistance and Training--

AID provides technical assistance and training to all the Asian malaria control programs. An interregional environmental health program currently provides on-site technical assistance to Nepal, Indonesia, Pakistan, and Sri Lanka (26). Additional technical assistance is also supplied to these countries through individual country loans and grants for malaria control. Training of field personnel is included in the Nepal program (13).

In response to the episode of malathion intoxication of field supervisors, mixers, and spraymen in the Pakistan Malaria Control Program in 1976, which is discussed in detail in Chapter IV, page 226, AID will provide additional training and technical assistance to both the Pakistan Malaria Program and other malaria programs in which toxic insecticides such as malathion are used. Specifically, the following actions to prevent the future intoxication of workers using malathion in Pakistan will be taken: pay special attention to workers identified as having low cholinesterase levels and prevent workers who become intoxicated from returning to work for at least 2 weeks; train malaria supervisors to recognize early symptoms of intoxication; train personnel for reference laboratories for performing cholinesterase determinations and periodically evaluate their performance; train workers to use good work practices and train provincial and district personnel as safety officers to assure good practices are conducted; supply safety equipment to workers; improve shipment storage and handling procedures; and recommend discontinuing the use of the highly toxic Snia Viscosa and Rumianca products immediately (31).

In general the following training and technical assistance will be provided for malaria programs which employ malathion insecticide: train a person to monitor the receipt, testing, storage, and use of malathion in each area that it is used; establish and monitor safety measures recommended by WHO to be used to protect any person from intoxication; undertake a feasibility study to evaluate the toxicological testing of toxic pesticides used; conduct research on the methods of analyzing malathion

for toxic components; encourage surveillance to identify toxic effects of pesticide on spray workers and general population; and conduct research on improving the accuracy of field methods used in the determination of cholinesterase levels. These training and technical assistance activities will require, or have already required, additional funds and manpower in the current and future programs.

Technical assistance and training would be funded in the anticipated Sri Lanka malaria program, but the $5 million loan has not yet been authorized (26,21).

Research Activities--

Mosquito resistance to DDT is an increasing problem in many regions of the world. AID currently funds field testing of fenitrothion, malathion, and biodegradable DDT in Indonesia as DDT alternatives. Financing of field tests is through an interregional environmental health program. Only limited quantities of fenitrothion and biodegradable DDT have been applied under very controlled conditions (26).

Research activities are also financed through malaria control programs in Nepal and Indonesia. Malaria incidence in Indonesia will be determined by malariometric surveys and epidemiology studies. Epidemiological studies will also be financed through Nepal's malaria program (26,21).

A historical review of completed, and in some incidences ongoing, research programs is given in Chapter I (page 74). The AID public health programs for Asia are summarized in Table 41.

Near East

There are no current AID public health programs for the Near East. However, plans anticipate the establishment of AID public health activities in the Near East by the end of 1978, but planning is in the developmental stage, and specific programs and activities cannot be projected at this time.

Table 41: AID Public Health Programs for Asia

Country	Project/Program	Program Element[a/] P.A.	O.P.	T/TA	R.	Comments	Pesticide
Indonesia	Malaria Control, Loan No. 497-U-034; authorized 6/18/74	X		X	X	Loan will finance training of Indonesian personnel, epidemiological and malariometric surveys, and the procurement of pesticides	Amount over 5 years 17.2 million kg (19,000 tons) DDT, 450 kg (1,000 lb) malathion
Nepal	Malaria Control, Grant No. 367-11-590-115, FY 1976 to FY 1979	X				FY 1976: $1.8 million provided for insecticide purchases	DDT; possible use of malathion
				X		FY 1976: technology assessment in establishing the program; training of Nepalese in the U.S.; one person there as of May 1, 1976	
				X		FY 1977: retraining programs for field workers; assist in planning procurement of additional materials and supplies	
Pakistan	Malaria Control, Loan No. 391-U-163, authorized 6/30/75	X		X		Loan of $7.5 million to finance technical assistance, training, and pesticide procurement	Malathion, DDT, and BHC
Sri Lanka	Malaria Control, Project loan, initial obligation, FY 1977	X				Project spraying projects to reduce the vector malathion; purchase allotted $4.9 million	Malathion only
				X		Project training and retraining of field workers	

a/ P.A. = Pesticide activity
O.P. = Other pest management activities not involving pesticide activity
T/TA = Training/technical assistance
R = Research

USE OF DDT IN AID-SUPPORTED ANTIMALARIA PROGRAMS

AID pest management activities in public health programs in less developed countries are focused mainly on the control of vector-borne endemic diseases, especially malaria. By far the most important insecticide in past and present public health vector control programs was and is DDT. Thus, large shares of AID's contributions to vector control programs in less developed countries have been used to finance purchases of DDT.

Few if any other chemicals known to man have been investigated as extensively as DDT in research studies, under a wide variety of field use conditions, in legal proceedings, and in public debates. Controversies about DDT and the benefits and risks associated with its use continue to this date. For this reason, the use of DDT in antimalaria programs, including programs supported by AID, is being reviewed in this chapter in some detail.

Role of DDT in Worldwide Antimalaria Programs

Among the vector-borne diseases affecting people in tropical and subtropical areas of the world, malaria ranks highest for the extraordinary amount of mortality and morbidity that it causes (32). Following evidence of the success of residual house sprays of DDT in eliminating the transmission of malaria by anopheline mosquitoes, a global malaria eradication campaign was inaugurated by WHO in 1956 (33,29). AID's mandate to support worldwide malaria eradication, and to convert existing U.S. supported malaria control to eradication programs was legislated in Section 420 of the Mutual Security Act of 1957 which said:

> "The Congress of the United States, recognizing that the disease of malaria, because of its widespread prevalence, debilitating effects, and heavy toll in human life, constitutes a major deterrent to the efforts of many people to develop their economic resources and productive capacities and to improve their living conditions, and further recognizing that it now appears technically feasible to eradicate this disease, declares it to be the policy of the United States and the purpose of this section to assist other peoples in their efforts to eradicate malaria."

Subsequent Mutual Security Acts for the years 1958, 1959, and 1960 contained specific appropriations for malaria eradication programs. There is no evidence that Congress or subsequent Administrations have withdrawn their support for worldwide efforts to control or eradicate malaria (11).

AID programs and activities instituted pursuant to these congressional mandates between 1957 and 1975 are summarized in Chapter II, page 157 and reported in greater detail in an audit report (11) entitled "Malaria Eradication Programs," Appendix F, of this EIS. Currently identified (through 1978) AID-assisted antimalaria activities are included in the discussion of public health programs in this chapter.

In the worldwide malaria eradication program spearheaded by WHO, each national campaign was estimated to take at least 8 years, according to the following phases (33,11):

(1) Preparatory phase (1 to 2 years) - establishes the antimalaria organization including staffing, training, education, logistical arrangements, and epidemiological and geographical surveys. All of these activities continue in the later phases.

(2) Attack phase (3 to 4 years) - interrupts malaria transmission, mainly by domiciliary spraying with DDT at 2 g/sq m. In some programs, dieldrin at 0.6 g/sq m or gamma-BHC at 0.5 g/sq m were also used. In early attack, malariometric surveys provide evaluation and guidance of operations. In late attack, after reduction of malaria prevalence to less than 5%, total coverage by case detection and treatment services are established. When malaria incidence is reduced to 0.01%, this phase ends and general spraying coverage is withdrawn.

(3) Consolidation phase (3 to 4 years) - continues and intensifies surveillance to eliminate remaining malaria reservoirs, with epidemiological investigations and remedial measures for each discovered case. This phase ends when the eradication objective has been achieved, i.e., when adequate surveillance has shown no indigenous malaria problem for three consecutive years.

(4) Maintenance phase - provides a permanent vigilance system, integrated into the general health services, to prevent reestablishment of malaria transmission. This protective coverage is especially important in areas vulnerable to the reintroduction of malaria.

In 1958, the malaria eradication campaign included 76 countries. The attack phase reached its peak in 1961/1962 when about 65,000 MT DDT, 4,000 MT dieldrin, and 500 MT gamma-BHC were applied annually in the campaign. No adverse symptoms were noted among the 130,000 spraymen involved, nor in the 575 million occupants of the estimated 100 million dwellings sprayed (33;29,34).

Human populations in affected areas passed from the consolidation to the maintenance phase at the rate of 100 million per year in 1964, 1965 and 1966 (34). Between the late 1950's and 1970, malaria was eradicated from areas inhabited by 650 million people, and some 700 million people were freed from the threat of endemic malaria. It is estimated that malaria eradication programs prevented the occurrence of well over 2 billion cases of malaria, and 15 million deaths from the disease (35). Table 42 shows a numerical comparison of the populations of the malarious areas of the world in various phases of eradication between 1959 and 1970. The data show that by 1970, well over one billion people had been freed from the risk of malaria (32).

In many areas, the improvement in health brought about by the antimalaria campaigns broke the vicious circle of poverty and disease by preventing incapacity and death due to malaria and reducing the high socioeconomic costs of treatment and medical care. It contributed to the increased production of rice, for example, in the Philippines, Thailand, and Venezuela, by increasing the work output of the labor force. It allowed vast areas of land to be opened up for agricultural production, as in the Terai of India and Nepal and in Central Taiwan, and augmented land value in areas where only subsistence level farming could previously be sustained, as in Kunduz in Afghanistan, Cham in the Khmer Republic, or Mindanao in the Philippines (32).

These achievements were made possible by DDT and its unique combination of properties: high toxicity to insects, low toxicity to man and other animals, long residual action, ease of formulation, simplicity of application, and low cost (35).

The progress and results of the global malaria eradication campaign summarized in the preceding paragraphs were described and evaluated in greater detail, including coverage of regional developments, by Bruce-Chwatt (35,36), Brown (34), Brown et al. (33), Johnson (37), National Academy of Sciences (29), and others, as well as in annual WHO operational reports. Most of these successes were accomplished between 1956 and about 1965.

From the mid-1960's on, overall progress of the worldwide effort slowed down considerably, and endemic malaria resurged in places where it had been either controlled or virtually eradicated. The experience in Sri Lanka is a case in point, as the following WHO data illustrate (38):

Table 42: Status of Worldwide Antimalaria Program 1959 and 1970

Program Phase	Population in malarious areas			
	1959		1970	
	millions	%	millions	%
Maintenance phase (malaria eradicated)				
tropical areas	22	1.7	361	20.0
other areas[a/]	257	19.8	349	19.4
Consolidation phase (free from endemic malaria)	55	4.2	296	16.4
Attack phase (protected through spraying operations)	505	38.9	329	18.3
Protected population	839	64.6	1,335	74.1
Not protected[b/]	459	35.4	467	25.9
Total population in malarious areas[c/]	1,298	100.0	1,802	100.0

a/ Primarily North America and Southern Europe.

b/ Includes populations in areas in the preparatory phase of malaria eradication programs, and in areas where malaria control operations are being undertaken.

c/ Does not include China (Mainland), North Korea and North Vietnam.

Source: Adapted from Reference 32.

Year	No. of malaria cases
1946	2,800,000
1961	110
1962	31
1963	17
(DDT spraying discontinued in 1964)	
1964	150
1965	308
1966	499
1967	3,466
1968-1969	2,500,000

In those countries which failed to achieve eradication or to maintain it, several factors contributing to these failures were identified. These include overconfidence (premature scaling down of program); disappointment that time-limited eradication on the optimistic schedule originally contemplated was not achieved; greater mobility of the human malaria reservoir due to development projects such as agricultural programs, construction of roads, dams, etc.; creation of new mosquito breeding areas through construction of irrigation systems, fish-raising ponds, etc.; lack of trained personnel and training facilities; inadequate post-attack phase surveillance and case detection; and inadequate commitments by national governments.

Several factors associated with the insecticides used in the program, especially DDT, also caused difficulty. The present discussion will focus on these latter factors. For a more complete review of other causes of malaria resurgence, the reader is referred to the AID (1976) audit report on malaria eradication programs, Appendix F of this EIS, or to the comprehensive treatments of the subject in the reports previously cited, especially Brown et al. (33).

Problems Associated with the Use of DDT

Problems associated with DDT which caused increasing difficulties include vector resistance, environmental contamination, and increasing costs. The first two of these problems are reviewed in this subsection, followed by a discussion of the human health risks of DDT.

Vector Resistance--

Mosquito resistance to DDT became an increasingly negative impact on the antimalaria program in the 1960's. By 1971, DDT resistance had appeared in 15 species of anopheline mosquitoes in Central America, the

Persian Gulf area, Java, and parts of India, Turkey, and Syria. In many of these areas, particularly in Central America, this mosquito resistance had been induced mainly by the contamination of larval breeding areas with insecticides applied to agricultural crops, especially cotton (11,33,34,39). By 1975, the number of species of anopheline mosquitoes resistant to DDT had increased to 24 (39).

Unlike resistance to dieldrin, DDT resistance in many areas had been moderate and could be successfully counteracted by reducing the spraying cycle. Therefore, DDT remained effective and useful in most antimalaria programs. According to WHO data, about 26,000 MT of DDT active ingredient were actually used in antimalaria programs worldwide in 1975, and an estimated 21,000 MT will still be required in 1980 (40).

Environmental Contamination--

The large-scale worldwide use of DDT (including agricultural, public health and all other uses) has resulted in a number of unintended and undesirable effects, including adverse effects on beneficial insects, on fish and other useful aquatic organisms including arthropods, mollusks, other invertebrates, and phytoplankton; and on some species of terrestrial wildlife and birds. Due to its lipophilic properties and persistence, DDT is bioaccumulated and stored in tissues of insects, algae, plankton, in the eggs of fish and birds and, particularly, in adipose tissues. It is biomagnified in food chains and therefore, some species of raptorial birds and fish at the top of food chains have been particularly affected. There is very extensive literature on this subject, and findings and conclusions of some investigators have been questioned by others.

Galley (41) studied the contribution of DDT as used in public health programs to the total DDT pollution of the environment. He reviewed and tabulated a large volume of data on the presence of DDT residues in air, soil, soil invertebrates, water, and aquatic vertebrates and invertebrates.

Based on WHO data (32), Galley calculated that of the total worldwide use of DDT around 1970, about 15 to 20% was used for public health purposes. He further estimated that of the total quantity of DDT used as residual wall spray in adult mosquito control, 5% may fall outside of treated huts, and an additional 5% may be swept out of treated huts as dust. Thus, 10% of the quantity applied may have the same environmental mobility as the quantities of DDT discharged directly into the ecosphere in the course of its use in agriculture, forestry, horticulture, and for other outdoor purposes. An estimated 90% of the quantities of DDT applied as residual wall spray in rural dwellings in antimalaria operations remains firmly sorbed in dry mud and could conceivably get into circulation again only if individual huts or entire villages were abandoned, the huts knocked down, and the area returned to agricultural usage or wilderness. Assuming that these hut-bound DDT residues might eventually contribute to environmental

contamination at the rate of 25% of those applied directly into the environment, Galley calculated that overall, DDT used against malaria vectors would contribute to global DDT contamination at the rate of about 8% of the whole.

Other studies (32) indicated that in the process of spraying houses with DDT, 6% of the spray is deposited on the floor inside, and some 2% on the outside soil around treated houses. The deposit outside houses, if calculated for rural areas with an average of 100 inhabitants per square kilometer as in parts of tropical Africa, would amount to a DDT input of 10 g/ha; this is 0.5% of a standard DDT application of 2 kg/ha as employed on cotton and other crops. Additionally, whereas only one or two applications of DDT are made to houses per year, multiple applications are made to cotton during the growing season.

Based on actual measurements in the field, Brown (34) reported that the outdoor DDT contamination entailed in spraying one village is equivalent to about 0.1% of the quantity required to spray for one season one cotton field of an area equal to that of the village. He further reported that no deleterious effects on wildlife have been observed during the malaria attack phase in any country. No specific investigations have been made of possible subsurface effects because villagers in treated areas were often using so many organochlorine insecticides on their crops that the effect of antimalarial spraying could not have been ascertained.

Human Health Risks--

According to Hayes (42), who conducted studies on the toxicity of DDT and reviewed its hazard to man based on his own and other investigators' work, the safety record of this insecticide for man is truly remarkable. Several hundred thousand metric tons per year have been used worldwide for agriculture, forestry, public health, and other purposes. People have been exposed to DDT in almost every way conceivable. For typhus control, entire populations of villages and large cities have had 10% DDT dust blown into their clothing as they wore it. In antimalaria programs, millions of men, women, and children have had the interior walls of their homes sprayed year after year at the rate of 2 g/sq m. For control of yellow fever mosquito, DDT has been added directly to community water supplies at a concentration of 1 ppm, and to individual home water containers at concentrations up to 5 ppm.

The conventional indoor application of DDT in antimalaria programs is an operation that cannot be carried out without subjecting spraymen to severe, prolonged, and repeated exposure (43). No adverse symptoms were noted among 130,000 spraymen involved in the application of DDT at the height of the malaria eradication attack phase in the early 1960's, nor in the 575 million occupants of the more than 100 million dwellings sprayed (33).

In spite of these extensive, heavy exposures to DDT of large numbers of people worldwide, and the even heavier occupational exposure of a substantial number, the only confirmed cases of poisoning by DDT have been the result of massive accidental or suicidal ingestion (42).

Thus, toxicity of DDT to humans has never been a first-order problem in antimalaria operations. Nevertheless, WHO has been concerned about actual or potential human health risks of DDT for many years not only because of its use against malaria, but also from the point of view of the establishment of international tolerances for pesticide residues in food. For these reasons, WHO has studied and evaluated possible human hazards arising from the use of DDT at least since 1961. To perform such evaluations, WHO convenes panels of independent experts who study published and unpublished toxicological and other pertinent data. For the establishment of tolerances for pesticide residues in food, the WHO Expert Committees usually meet jointly with the FAO Working Party of Experts on pesticide residues.

Human health hazards of DDT were reviewed frequently by these FAO/WHO Joint Meetings, including those held in 1965, 1970, 1972, 1973, and 1974. The names and affiliations of the experts from different countries who participated in these evaluations are given in Table 43.

In 1965, the Joint Meeting established an acceptable daily intake (ADI) of DDT for man of from 0 to 0.01 mg/kg/day. This level was set in view of the vast amount of information on the metabolism, fate, and toxic effects of DDT in man obtained from observations of large numbers of people in many countries (44,45).

The Joint Meeting in 1969 considered a publication of Tarjan and Kemeny (46) who reported that long-term exposure of several generations of mice to DDT resulted in an increasing incidence of tumors at various sites in later generations. Based on these findings, the ADI of DDT was changed to a "conditional ADI" and lowered from 0.01 to 0.005 mg/kg/day (48).

At the 1970 Joint Meeting, the matter was reconsidered. As the further studies on DDT initiated by WHO and the International Agency for Research on Cancer were still in progress, the conditional ADI established for DDT in 1969 was not changed (47).

Two additional studies on mice were available at the time of the 1972 Joint Meeting, both confirming earlier reports to the effect that in chronic feeding studies, DDT increased the incidence of parenchymal liver cell tumors, some of which were malignant. However, the results of both tests did not confirm the occurrence of tumors at multiple sites,

Table 43: Names and Affiliations of Experts Who Evaluated DDT Toxicity Data as Members of the WHO Expert Committee on Pesticide Residues at the 1965, 1970, 1972, 1973 and 1974 WHO/FAO Joint Meetings

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Dr. W. F. Almeida, Director, Division of Animal Biology, Biological Institute, Sao Paulo, Brazil; 1970, 1972.

Dr. E. Astolfi, Professor of Toxicology, University of Buenos Aires, Argentina; 1974.

Dr. L. R. Axelrod, Environmental Protection Agency, Washington, D.C., USA; 1974.

Professor F. Bär, Max von Pettenkofer Institute, Berlin, Federal Republic of Germany; 1965.

Dr. F. Benes, Institute of Hygiene, Prague, Czechoslovakia; 1965, 1970, 1972.

Mr. W. Burns-Brown, Pest Infestation Laboratory, Slough, England; 1965.

Mr. D. J. Clegg, Head, Pesticide Unit, Division of Toxicology, Food Advisory Bureau, Health Protection Branch, Ottawa, Ontario, Canada; 1972.

Professor F. Coulston, Director, Institute of Experimental Pathology and Toxicology, The Albany Medical College of Union University, Albany, N.Y., USA; 1970.

Professor Sv. Dalgaard-Mikkelsen, Royal Veterinary and Agricultural College, Copenhagen, Denmark; 1970.

Dr. H. Drees, Federal Ministry of Food, Agriculture and Forestry, Bonn, Germany; 1965.

Dr. G. J. van Esch, National Institute of Public Health, Utrecht, Netherlands; 1965.

Dr. Roy Goulding, Ministry of Health, London, England; 1965.

Dr. G. V. Graceva, All-Union Research Institute for Hygiene and Toxicology of Pesticides and Polymers, Kiev, Ukrainian SSR; 1973.

Dr. W. J. Hayes, Jr., Communicable Disease Center, United States Public Health Service, Atlanta, GA., USA; 1965.

Dr. H. Hurtig, Research Branch, Canada Department of Agriculture, Ottawa, Canada; 1965.

Dr. F. P. Kalojanova-Simeonova, Professor of Toxicology, Director, Research Institute of Hygiene and Occupational Health, Sofia, Bulgaria; 1973.

Dr. H. A. U. Monro, Agricultural Research Institute, Research Branch, Canada Department of Agriculture, London, Ontario, Canada; 1965.

Dr. S. D. Murphy, Associate Professor of Toxicology, Harvard University, School of Public Health, Boston, Mass., USA; 1972, 1973.

Table 43 (Concluded): Names and Affiliations of Experts Who Evaluated DDT Toxicity Data as Members of the WHO Expert Committee on Pesticide Residues at the 1965, 1970, 1972, 1973 and 1974 WHO/FAO Joint Meetings

Professor I. Nir, Head, Department of Clinical Pharmacology, Ministry of Health, Jerusalem, Israel; 1972, 1973, 1974.

Professor F. K. Ohnesorge, Head, Department of Toxicology, Institute of Pharmacology, University of Kiel, Federal Republic of Germany; 1973, 1974.

Dr. Y. Omori, Head, Department of Pharmacology, National Institute of Hygienic Sciences, Kamiyoga, Setagaya, Tokyo, Japan; 1970.

Dr. E. Poulsen, Director, Institute of Toxicology, National Food Institute, Soborg, Denmark; 1970, 1973, 1974.

Dr. F. J. C. Roe, Head, Department of Experimental Pathology, Chester Beatty Research Institute, Institute of Cancer Research, Royal Cancer Hospital, London, England; 1970, 1973.

Professor Dr. L. Rosival, Director, Research Institute of Hygiene, Bratislava, Czechoslovakia; 1974.

Dr. Y. K. Subrahmanyam, Directorate General of Health Services, New Delhi, India; 1965.

Professor A. H. Sundwall, Department of Pharmacology, University of Uppsala, Sweden; 1973.

Professor R. Truhaut, Director, Toxicological Research Centre, Faculty of Pharmaceutical and Biological Sciences, Rene Descartes University, Paris, France; 1965, 1974.

Dr. H. G. Verschuuren, Head, Department of Biological Toxicology, National Institute of Public Health, Bilthoven, Netherlands; 1970, 1972.

Professor S. E. Wright, University of Sydney, Australia; 1965.

Note: Years after each person's name indicate Joint Meetings attended.

Source: FAO/WHO (44,47,48,49,50).

nor was there any increase in the incidence of tumors at any site from the first generation to the second. The Joint Meeting noted that the lowest dose tested in these studies was more than 100 times the average daily intake for man and decided that the conditional ADI of 0.005 mg/kg/day should be maintained, subject to reconsideration (48).

The 1973 Joint Meeting dealt with, among other things, the significance of the development of liver cell tumors in mice, especially the problem of interpreting data in respect to carcinogenicity where exposure of mice to a pesticide increases the risk of development of liver tumors. It is known that in several strains of mice, liver tumors, including some that metastasize to the lungs, may arise in untreated animals, and that the rate may be as high as 100%. The experts concluded that there was a serious lack of knowledge regarding the processes involved in the development of liver tumors by mice, and that it would be unwise to classify a substance as a carcinogen solely on the basis of evidence of an increased incidence of tumors of a kind that may occur spontaneously with such high frequency (49).

The 1974 Joint Meeting considered then unpublished data by Tomatis and Turusov demonstrating that mice ingesting 36 mg of DDT per kilogram of body weight in their food for 15 weeks developed hepatomas that did not regress. However, no tumors were produced in other species tested in the same manner, e.g., rats and hamsters. The experts also considered the fact that limited epidemiological data available gave no indication that DDT might be a human carcinogen. They stated that a number of people have had intermittent heavy exposure to DDT over a period of some 30 years which should have been sufficient time to produce and observe increased tumor incidence, had it occurred (50).

In addition to these regular reviews of the human health hazards of DDT by its Expert Committee on Pesticide Residues, WHO arranged for an evaluation of the carcinogenic risk of DDT to man by the International Agency for Research on Cancer (IARC) (51). The names and affiliations of the members and invited guests of the Working Group who undertook this evaluation are listed in Table 44. These experts served in their individual capacities as scientists, not as representatives of their governments or of organizations with which they were affiliated.

This Working Group considered more than 200 reports on the properties and effects of DDT and some of its analogs and derivatives, including chemical and physical data; technical products and impurities; production, use, and analysis; occurrence in human tissues, air, rain, soil, water, animals, plants, and food; and metabolism and storage in man and animals. Carcinogenicity and related studies in animals which were reviewed included 10 different studies on mice, four on rats, and one each

Table 44: Names and Affiliations of Experts Who Evaluated the Carcinogenic Risk of DDT as Members of a Working Group of the International Agency for Research on Cancer

Members

Dr. D. C. Abbott, Senior Superintendant Environmental Chemistry, Laboratory of the Government Chemist, Department of Trade and Industry, Cornwall House, Stamford Street, London SE1 9NQ, UK.

Dr. R. D. Kimbrough, U.S. Environmental Protection Agency, 4770 Buford Highway, Chamblee, Georgia 30341, USA. Present address: Centre for Disease Control, 9600 Clifton Road, Atlanta, Georgia 30333, USA.

Dr. R. Kroes, Head of the Department of Oncology, Laboratory for Pathology, Rijks Instituut voor de Volksgenzondheid, Postbus 1, Bilthoven, The Netherlands.

Professor M. Kuratsune, Department of Epidemiology, Medical School of Fukuoka, Kyushu University, Fukuoka, Japan.

Dr. J. L. Radomski, Professor of Pharmacology, University of Miami, School of Medicine, Box 875 Biscayne Annex, Miami, Florida 33152, USA.

Dr. U. Saffiotti, Associate Director for Carcinogenesis, Division of Cancer Cause and Prevention, National Cancer Institute, National Institutes of Health, Bethesda, Maryland 20014, USA.

Dr. M. Sharratt, Senior Medical Officer, Department of Health and Social Security, Alexander Fleming House, Elephant and Castle, London SE1 6BY, UK.

Dr. P. Shubik. Director, The Eppley Institute for Research in Cancer, University of Nebraska Medical Center, 42nd and Dewey Avenue, Omaha, Nebraska 68105, USA.

Dr. B. Terracini, Istituto di Anatomia e Istologia Patologica dell' Universita di Torino, via Santena 7, Turin 10126, Italy.

Invited Guests

Dr. L. Axelrod, U.S. Environmental Protection Agency, Room 519, Waterside Mall, West Tower, 401 M Street S.W., Washington, D.C. 20460, USA.

Miss I. B. Bertram, Deutsches Krebsforschungszentrum Institut für Toxikologie und Chemotherapie, Kirschnerstrasse 6, Postfach 449, D 6900 Heidelberg 1, Federal Republic of Germany.

Mr. J. C. Kolojeski, Attorney, U.S. Environmental Protection Agency, Room 519, Waterside Mall, West Tower, 401 M Street, S.W., Washington, D.C. 20460, USA.

Dr. K. E. McCaleb, Manager, Environmental Studies, Chemical Information Services, Stanford Research Institute, Menlo Park, California 94025, USA.

Representative from the National Cancer Institute

Dr. S. Siegel, Research Biologist, Carcinogen Bioassay and Programme Resource Branch, Carcinogenesis DCCP, National Cancer Institute, Landow Building, Room C 325, Bethesda, Maryland 20014, USA.

Source: International Agency for Research on Cancer (51).

on hamsters, dogs, monkeys, and trout. Observations in man included three studies, one of 40 men engaged in the manufacture or formulation of DDT for periods of less than 1 and up to 8 years (52), one of 35 workers with extensive occupational exposure exclusively to DDT for periods of 11 to 19 years (53), and one of 24 volunteers from a penitentiary who participated in a study involving exposure to DDT at 3.5 and 35 mg/man/day for 21.5 months (54). No evidence of neoplasia was found among any of the workers or volunteers in any of these three studies.

The Working Group's findings, based on their evaluation of these extensive data, were as follows:

The hepatocarcinogenicity of DDT by the oral route has been demonstrated in several strains of mice. Liver cell tumors have been produced in both sexes, and in one strain of mice some were found to have metastasized. Increased tumor incidences were found in some other organs in one study, but this finding was not confirmed in two more recent multigeneration studies using a wide range of dosage rates.

Oral administration studies in rats provided no convincing evidence of carcinogenicity of DDT to this species. Hamsters tolerated higher dietary intakes of DDT than mice or rats and did not develop tumors in excess over the controls.

Studies with dogs, monkeys, and trout were considered inconclusive due to limitations in group size, duration of treatment, and/or control of diets.

Epidemiological studies on workers exposed to DDT and the study on volunteers were too limited and/or too short to allow conclusions regarding carcinogenesis. Although fat concentrations of DDT residues were higher in terminal cancer patients than in control patients, this finding was considered inconclusive regarding a causal relationship, and a similar study with a different design did not show such a result.

Several additional studies on the effects of DDT on humans and on experimental animals which were not available to the IARC Working Group during its deliberations in 1973 were reported recently.

Laws et al. (55) investigated the hepatic effects of long-term occupational exposure to high levels of DDT. Workers exposed to DDT at rates equivalent to oral intakes of 3.6 to 18 mg daily for periods ranging from 16 to 25 years and averaging 21 years were studied. The group consisted of 31 of the 35 occupationally exposed workers who were studied in 1966 (53). The ages of the 31 men ranged from 37 to 67 years, with a mean of 48 and a median of 47 years. Based on the findings of extensive medical

inquiries, liver function tests, and DDT serum levels, no evidence of hepatic disease or liver function abnormalities was detected.

Four of the 35 men studied in 1966 were not available for this study; one had left the DDT plant for reasons not related to health and could not be located, two were retired and were both free of known liver disease or other major illness at the time of this inquiry, and one, 50 years old, with no known liver disease, was hospitalized for cholecystectomy.

The authors comment that previous investigations and the results of their study have failed to detect any evidence of DDT-induced hepatotoxicity, hepatic enlargement, or liver dysfunction in man. DDT workers showed symptoms of increased activity of hepatic microsomal enzyme, but there is no evidence that this effect is detrimental to general health, nor is it qualitatively different from enzyme stimulation produced by drugs, other pesticides, foods, or food additives.

Poland et al. (56) studied the effects of intensive occupational exposure to DDT on phenylbutazone and cortisol metabolism in a group of 18 human volunteers from the same DDT plant which had furnished the subjects for the studies by Laws, Curley and Biros (53) and Laws, Maddrey, Curley, and Burse (55). The average duration of employment in the DDT plant of the men in this study was 14.4 ± 1.2 years. A control group of 18 men consisted of policemen and firemen and two other persons, each of whom were picked to match a DDT factory worker in regard to age, ethnic origin, smoking and alcohol consumption habits, and medication. The concentration of DDT-related substances in the serum and fat of the DDT factory workers was 20 to 30 times that in the control population. The serum half-life of phenylbutazone was 19% lower, and the urinary excretion of hydroxycortisol was 57% higher in the DDT factory workers; both of these differences were significant at $p < 0.01$. There was considerable variability in these parameters both among the DDT factory workers and in the control population, but it was not correlated with the concentration of DDT in the serum.

WHO organized two studies on the health of spraymen engaged in malaria eradication campaigns (57). In one of these, the Biological Institute of Sao Paulo, Brazil, performed periodic clinical examinations of 202 spraymen exposed to DDT for 6 or more years, of 77 spraymen exposed to DDT for 13 years from 1947 to 1959, and of 78 men who lived in houses sprayed indoors with DDT every 6 months. A control group consisted of 406 men whose age distribution and socioeconomic level were similar to those of the exposed groups. Over a 3-year period, a survey of illnesses requiring medical care did not show any differences between the exposed groups. Clinical examinations carried out at 6-month intervals showed no clinical differences between the exposed and the control groups. A relatively small number of serum analyses indicated a DDT level in spraymen approximately three times that of the controls.

The Indian Council of Medical Research collected blood specimens from 100 men who had sprayed DDT indoors for five or more years, and from 98 controls. The mean concentration of total DDT in the serum was 1.272 and 0.170 mg/liter in the exposed and control groups, respectively. No adverse effects on the health of the exposed persons were discovered, even in spraymen who have had more than 15 years of exposure to DDT.

Ottoboni et al. (58) studied the effects of DDT on reproduction in multiple generations of beagle dogs. The study included a total of 135 adult female and 63 adult male dogs which produced 650 pups. DDT (technical grade) was applied at rates of 1, 5, and 10 mg/kg/day, and effects measured included age at puberty, length of gestation, fertility, success of pregnancy, litter size, lactational ability of dams; viability, survival to weaning, sex distribution, and growth of pups; and morbidity, mortality, organ/body weight ratios, and gross and histologic abnormalities in all animals through three generations.

Results showed no statistically significant differences among control and DDT-treated dogs in any of the reproductive variables, with the exception of age at puberty of the females. DDT-treated females had their first estrous cycles 2 to 3 months earlier than the control dogs (this effect was significant at $p < 0.001$). There were no effects of DDT on survival, growth, or sex distribution of pups, nor on morbidity, mortality, or gross or histologic findings in any of the dogs. All organ/body weight ratios were normal, with the possible exception of an increase in liver/body weight ratio in some DDT-treated animals.

Laws (59) subjected mice exposed to a chronic dosage of 5.5 mg/kg/day of DDT in their diets to transplants of an ependymoma, an experimental tumor uniformly transplantable and lethal to rodents. Compared to untreated controls, the treated animals showed a decrease in the percentage of tumor transplant takes, and a significant increase in longevity. Necropsies on all animals revealed no evidence of liver tumors or other hepatic pathological findings. All animals in the experimental group were maintained on the DDT diet from the age of 5 weeks until they died, or until the experiment was terminated after 16 months.

Silinskas and Okey (60) reported on the protection of rats by DDT against mammary tumors and leukemia induced by prolonged feeding of DMBA, a potent carcinogen. Female rats 36 days old were pretreated for 2 weeks with 100 ppm DDT in the diet. Thereafter, they received, via stomach tube, 21 consecutive daily doses of 0.714 mg of DMBA (7,12-dimethylbenz[a]anthracene). The DDT diet and observation of the animals for mammary tumors continued until necropsy, 230 days after the start of DMBA administration. The DDT-treated rats had a significantly lower mammary tumor incidence, prolonged tumor latency period, and fewer tumors per rat than the control group. Leukemia incidence in rats surviving to necropsy was 2 of 29 for DDT-treated, 11 of

20 for untreated rats. The investigators suggest that DDT may inhibit DMBA-induced mammary tumors and leukemia by stimulating hepatic metabolism and excretion of DMBA, resulting in reduced availability of carcinogen to peripheral tissues.

Under the same experimental conditions, malathion at 250 ppm in the diet for 2 weeks prior to DMBA administration potentiated the induction of mammary tumors and of leukemia by DMBA.

In his recent comprehensive treatise on the toxicology of pesticides, Hayes (61) summarized the situation as follows:

> "It is difficult to evaluate reports that large dosages of some pesticides have induced tumors and occasionally malignant neoplasms in experimental animals. This is especially true of DDT, which not only is reported to cause tumors of the liver in rodents, but also to discourage the transfer of an otherwise uniformly transplantable, lethal tumor in rats. DDT failed to produce detectable tumors in men who absorbed DDT for 19 years or more at rates hundreds of times higher than those of the general population (53). Furthermore, the detection of tumors in these men did not depend exclusively on medical history and physical examination. When it was recognized that the presence of alpha-fetoprotein in the blood of adults provides evidence for the presence of carcinoma of the liver in man, 33 of the most heavily exposed workmen were examined for this protein; the results were negative for alpha-fetoprotein in all of them (62).
>
> "As further evidence for the lack of correspondence between results in mice and people, one may consider the case of phenobarbital. Like dieldrin, it causes liver tumors in mice, and some of the tumors metastasize to the lungs (63,64). However, a study based on a complete tumor registry indicated no increase of tumors attributable to phenobarbital among men and women who received the heavy, essentially life-long dosage of this drug necessary for the control of epilepsy (65)."

Alternatives to DDT

Alternative Chemical Insecticides--

In 1960, WHO established a program for evaluating and testing insecticides with the objective of finding new compounds for vector control purposes that would overcome the problem of insecticide resistance and not lead to further contamination of the environment (66). This program consists of seven screening and testing stages, ranging from screening tests in one laboratory at Stage I to simulated and actual field tests in a number of

laboratories in different countries at Stages II, III, and IV; village trials at Stage V; operational field trials in Kenya involving human populations of up to 25,000 living in several thousand houses at Stage VI; and large-scale trials including full epidemiological evaluation involving populations of up to 100,000 at Stage VII.

From 1960 to 1974, about 2,000 candidate chemicals were examined in this program, and approximately 30 showed promise for vector control (67). Up to 1976, only five insecticides passed successfully through all screening and testing stages and were recommended by WHO for malaria vector control operations; they are DDT, BHC, dieldrin, malathion, and propoxur. A sixth compound, fenitrothion, successfully completed the final evaluation stage in 1976 (68) and is now also recommended for operational use.

Candidate chemicals have been supplied by some 50 firms and laboratories in nine countries. The number of chemicals being submitted annually declined from nearly 200 during the period 1962 to 1966 to an average of some 44 compounds recently, 1972 to 1974 (66,67).

In 1971, WHO, the Center for Disease Control of the U.S. Department of Health, Education, and Welfare, and Emory University jointly sponsored an international conference, held in Atlanta, Georgia, on alternative insecticides for vector control (69). At this meeting, scientists from universities, industry, and other organizations concerned with the synthesis and toxicity of insecticides and with vector control exchanged information and ideas on all classes of chemicals known to possess insecticidal activity. However, no conclusions were arrived at, no recommendations were made, and no priorities were established. The conference apparently did not succeed in re-increasing the flow of candidate insecticides into the WHO evaluation scheme, at least not up to the present.

At this conference, Barnes (43) emphasized that conventional indoor application of insecticides is the most important means of controlling malaria in most areas. It is an operation that cannot be carried out without subjecting spraymen to severe, prolonged, and repeated exposure. Under all reasonably forseeable conditions, spraymen will be severely exposed during indoor application. Candidate insecticides, regardless of how good in all other respects, are useless if they cannot be applied without making spraymen or occupants of treated dwellings ill.

Information available at the time of this conference (1971) indicated that malathion, which had been used quite extensively in antimalaria programs with little care, seemed to be safe; there was no evidence that toxic effects would result from the use of wettable powder formulations. However, when malathion was first used on a wide scale in antimalaria operations in Pakistan in 1976, cases of pesticide intoxication were observed within a few days of the start of spraying (31).

There were at least five deaths of spraymen which were probably related to malathion poisoning. Investigators attributed this epidemic of malathion intoxication to a combination of work practices formed while using DDT, and the usage of two brands of malathion containing toxic contaminants, although some of the poisoning cases were associated with the use of uncontaminated malathion.

These experiences underscore Barnes' 1971 statements and indicate that in antimalaria operations, malathion appears to have a narrower safety margin for humans than DDT. Barnes (43) suggested that propoxur (a carbamate) and fenitrothion (an organic phosphate) represent maximum tolerable levels of toxicity; no organophosphates or carbamates of higher acute oral or dermal toxicity to mammals should be accepted for vector control programs.

At the present time, only three nonorganochlorine insecticides, namely, malathion, fenitrothion, and propoxur, have been fully recommended for large-scale use in antimalaria programs (40). Table 45 presents a cost comparison between DDT, malathion, and propoxur as applied in residual spraying against malaria, excluding cost of application and other operational costs. To obtain efficacy for a period of 6 months, one DDT application at the rate of 2 g/sq m is sufficient, while both malathion and propoxur must be applied twice. The table shows that when a program shifts from DDT to malathion or propoxur, insecticide costs alone increase 5.6 or 20.2 times, respectively. Additional costs arise from the need for more frequent application of the replacement insecticides. Operational costs are estimated to be one-third to one-half of the cost of the insecticide.

Fenitrothion may also be used in full-scale antimalaria programs in the future, but no operational experiences with it are available to date since it was recommended only recently. Based on 1974 prices and the recommended rate of 2 g active ingredient/sq m/3 months, fenitrothion (insecticide only, not including application and other operational costs) would be 14.6 times more expensive than DDT (70,40). By October 1977, it is anticipated that two U.S. plants will be in production and costs may drop to eight times that of DDT.

The use of propoxur in antimalaria programs thus far has been limited to four Central American countries and Haiti where it was donated by the Government of the Federal Republic of Germany. Due to its high cost, no other antimalaria programs have been able to use it (71).

For these reasons, DDT and malathion are the only two insecticides currently expected to be used on a large scale in worldwide antimalaria programs between now and the early 1980's (40,71).

Table 45: Cost Comparison of Insecticides Used in Residual Spraying against Malaria Vectors[a/]

Insecticide	Rate required, g/m^2 per appl.	Rate required, g/m^2 for 6 mos.	Cost $/ton tech.	Cost for 6 mos., $/$m^2$	Ratio
DDT	2	2	770	0.2056	1
Malathion	2	4	1,440	1.15	5.59
Propoxur	2	4	5,200[b/]	4.16	20.2

a/ Does not include application and other operational costs.

b/ Prices 1973. No new quotation available.

Source: Rafatjah (70,71); WHO (40).

Bioenvironmental Vector Control Methods--

Methods of vector control not involving the use of chemical insecticides, also referred to as bioenvironmental methods, include environmental management, biological methods, and genetic methods (67).

In 1975, the UNEP and WHO jointly convened a meeting in Lima, Peru, for the purpose of stimulating the development and practical application of nonchemical methods of disease vector control. Meeting attendants included representatives from many countries in which malaria is an actual or potential problem, and from national and international organizations interested in antimalaria programs (72).

Items discussed at this conference included the current world malaria situation, the status of chemical and nonchemical vector control methods, systems approaches in antimalaria programs, training needs, information systems, and feasibility studies on comprehensive use of antimalaria methods. It was recognized that persistent insecticides used as indoor sprays in malaria control have not been major contributors to pollution of the environment. Nevertheless, it was recommended that bioenvironmental methods should be given greater emphasis in the future, including changing human behavior contributing to the perpetuation of malaria transmission.

The current status of bioenvironmental approaches to malaria control as reported at the conference and in other sources is summarized in the following subsections.

Environmental management--In malaria control, the term environmental management applies to any physical transformation of the environment that will result in the prevention, elimination, or reduction of malaria through the prevention or elimination of mosquito sources. Engineering activities may include water management operations such as ditching, draining, filling, and land leveling. Methods of environmental manipulation include changing water levels in lakes or reservoirs, flushing of streams, changing water salinity, flooding or dewatering of larval habitats, etc.

Most of these methods are expensive and involve permanent alterations of the environment. Sometimes changes in environmental conditions which discourage breeding of vector species may favor their replacement by other, more dangerous species.

Prevention and reduction of man-vector contact by proper site selection for human settlements, mosquito-proofing of dwellings and individual protection were described as measures which have not been widely practiced due to their practical limitations, but which should receive greater emphasis in future planning.

Larvivorous fish--For biological control of mosquito larvae, the mosquito fish, Gambusia affinis, is the principal control agent currently available for operational use. It was used in North America for the control of anopheline larvae at the beginning of this century and was later introduced to Europe and other continents and employed in antimalaria programs. The massive use of Gambusia in malaria programs was recently resumed, starting in 1966 in Iran and in 1972 in Afghanistan. Other programs subsequently adopted the method, and a survey of antimalaria projects in 1975 showed that over 30 were using fish, some in large-scale operations. In most of the countries, the fish already existed, and it was only necessary to develop a program of rearing and dissemination.

The fish were introduced in many types of mosquito breeding places, including marshes, swamps, ponds, streams, irrigation canals, rice fields, and wells. In most cases, there was a considerable reduction in the number of mosquito larvae and in the adult biting rate. There were indications that the effects on malaria transmission were also satisfactory, but the latter could not be substantiated because other control measures were in operation in the same areas.

Several disadvantages were also reported. Gambusia and other promising species of larvivorous fish are omnivorous and may therefore induce major and durable changes in aquatic ecosystems into which they are introduced. Furthermore, mosquito fish have no economic value, but devour young fish of desirable edible species. Where rapid and highly effective mosquito control is required, the use of fish often has to be supplemented by other control methods.

It was concluded that the use of larvivorous fish is best applied where the species to be released is already established and where resources are available for large-scale fish culture. In other areas, the possible environmental implications of the massive introduction of larvivorous fish should be carefully studied before any release is made.

In addition to Gambusia affinis, several other fish are also being studied for suitability in antimalaria programs, including the guppy, Poecilia reticulata, and two species of annual fish, Nothobranchius sp. and Cynolebias sp.

Insect pathogens--A number of biological agents including bacteria, fungi, microsporidia, nematodes, protozoa, and viruses are under study as possible mosquito control agents (33,34,67). None of these are currently ready for operational use or even approaching that stage. One of the reasons for this situation is that all promising organisms are pathogens which require thorough evaluation of their possible effects on nontarget organisms, including humans. WHO has established a scheme for assessing the efficacy and safety of biological agents similar to that used in the development of chemical pesticides, but no agents have progressed to advanced stages in this scheme as yet.

In 1972, WHO and FAO jointly convened a meeting for the purpose of evaluating the use of viruses for the control of insect pests and disease vectors (73). Meeting participants included experts from the United States, Canada, England, and France. Items considered included problems and priorities for the use of insect viruses to control disease vectors; characteristics and specificity of insect viruses; safety considerations and possible hazards in the use of insect viruses; and problems of production, application, field monitoring, and regulation. Research needs and priorities were identified. It was concluded that in the field of public health, information available on pathogenic insect viruses is sparse and fragmentary. It is evident from the record of this conference that insect viruses will not soon be available for operational use in malaria vector control operations.

At the UNEP/WHO conference (72), it was also pointed out that the massive use of microorganisms in countries other than those of their origin may be considered by some as a form of biological warfare. Extreme caution must therefore be exercised in carrying out safety studies and field trials, and the development process may require many years.

Genetic methods--Genetic control of anopheline mosquitoes by the sterile male technique has been under investigation for many years, and several field trials have been conducted in the United States, Central America, West Africa, and India. Insect sterility was achieved by chemosterilization or, in one case, by hybridizing of two anopheline species. Results obtained thus far are sometimes promising, sometimes inconclusive. Many scientific, technological, and logistical problems remain to be resolved.

The UNEP/WHO conference concluded that large-scale demonstrations of the sterile insect technique are technologically possible at this time. However, it was considered doubtful that the technique will become widely used in the near future since it requires appropriate laboratory colonies and methods for rearing, sterilization and handling for each species, and extensive biological and ecological studies in the field for each locale.

In sum, among all bioenvironmental methods of vector control currently under study, only two are available for operational use at this time and for the near-term future, i.e., environmental management methods and the use of larvivorous fish. Both of these methods are generally less selective and environmentally more disruptive than the use of DDT or other chemical insecticides as indoor residual wall sprays. All other nonchemical methods of malaria vector control are not likely to be able to contribute significantly to antimalaria programs during the next 5 to 10 years.

Immunization Against Malaria--

If people could be protected from malaria directly by immunization, control of malaria vectors may become unnecessary. Efforts to achieve such immunization date back to the second decade of this century, and such work gathered greater momentum in the early 1960's. Knowledge and

experience gained so far indicate that immunization against malaria appears to be feasible in principle and that therefore, further research is justified. Many scientific and technical problems remain to be resolved before immunization against malaria could become a practical reality.

The UNEP/WHO meeting concluded that in view of the worldwide difficulties the malaria program is facing, research in malaria immunization should be intensified, with special emphasis on the immune response, the development of suitable antigen, and procedures for its mass production (72).

As reported in Chapter I (page 74), AID has provided substantial support to research projects aimed at development of a malaria vaccine since 1966. In these projects, significant progress has recently been made in several critical areas. A researcher at Rockefeller University succeeded in culturing malaria parasites continually in vitro. At the University of Hawaii, a scientist successfully immunized laboratory monkeys against malaria with an experimental vaccine prepared from a culture of Plasmodium falciparum. Both of these accomplishments represent major breakthroughs and lend further encouragement to AID's efforts in this field. It is believed that there no longer is a question if a malaria vaccine is possible, the question is now when it will become available; this in turn will depend importantly upon the availability and timing of the additional resources required to complete the job.

Current Positions Regarding the Use of DDT in Antimalaria Programs

World Health Organization--

The use of DDT as an interior wall spray in houses to interrupt the transmission of malaria by mosquito vectors was the basis of various national malaria programs until 1956, of the world malaria eradication campaign 1956 to 1968, and continues to be the key element in current antimalaria operations under the revised strategy of control and eradication.

While WHO's original goal of rapid eradication of malaria proved to be unattainable because of a number of technical and other reasons, the global effort has nevertheless produced immense achievements; millions of people are now freed from the disease. Areas inhabited by nearly 800 million people, comprising most of the temperate zone countries, have been liberated from malaria; 770 million people live in areas where antimalaria operations are in progress. The global incidence of malaria is now about 120 million cases annually, of which nearly 100 million are in tropical Africa (33). The fact that this great public health endeavor is still incomplete and has experienced some reverses during the past years should not obscure its successes; it has made substantial progress towards reducing malaria from a worldwide pestilence to a regional or local disease.

As documented in the preceding subsections, WHO has not only used large quantities of DDT in this program, but has also carefully investigated, on a continuous basis, actual and potential adverse effects of its use, and encouraged and supported the search for chemical and nonchemical alternatives.

The Executive Board of the World Health Organization, during its 47th Session in Geneva in January of 1971, issued a policy statement on the place of DDT in operations against malaria and other vector-borne diseases. In this document (32), the use of DDT in public health, the effects of DDT on man and wildlife, alternatives to DDT, and consequences of withdrawal of DDT were assessed, based on many individual studies and a large volume of field experience. The conclusions were as follows:

> "Indoor spraying of DDT in routine antimalaria operations does not involve a significant risk to man or to wildlife. The withdrawal of DDT from malaria programs would be fraught with great danger and is unjustifiable in the light of present knowledge. The Organization would do everything in its power to insure that DDT remains available for this purpose.
>
> "The outdoor use of DDT should be avoided as far as possible."

WHO has not changed its position regarding the importance of DDT to antimalaria programs since the 1971 statement was published. If anything, malaria control is even more urgent today; 363 million people today live in malarious areas where no specific antimalaria programs exist.

National Academy of Sciences--

WHO's position regarding the use of DDT in antimalaria programs is fully supported and endorsed by the results of a comprehensive assessment of present and alternative technologies for pest control and public health performed by the Public Health Study Team of the Environmental Studies Board, National Research Council (29). The summary and recommendations of this report state as follows:

> "The study team recommends that some form of federal subsidy be considered to ensure the availability of critical limited-use pesticides at a reasonable cost.
>
> "The special cases of DDT and Paris green for public health use are examples of such materials. Although resistance and other problems limit the effectiveness of DDT in many areas, it remains the insecticide of choice in most malarious areas.

"Steps should be taken to ensure a continuing and adequate supply of high quality DDT formulations to meet the worldwide demand for domiciliary residual application in public health programs."

In the section on effects of restrictions on the use of pesticides, the NAS report states that the benefits of DDT for human health far outweigh the risks to the environment under conditions of supervised use.

U.S. Environmental Protection Agency--

In March 1971, EPA cancelled all registrations for DDT products and uses, including public health uses. Between August 1971 and March 1972, extensive hearings on the DDT cancellation were held which produced a transcript of 9,312 pages containing testimony from 125 expert witnesses and over 300 documents. On April 25, 1972, the Hearing Examiner before whom these hearings were held issued an opinion which recommended that all essential uses of DDT be retained, and that the cancellation be lifted. The Examiner found that DDT can have adverse effects on beneficial animals and that it is transferred through the food chain, but that it is neither a carcinogen nor teratogen, and that the particular uses at issue do not adversely affect wildlife.

In his final opinion and order issued June 14, 1972 (74), the EPA Administrator, contrary to the Hearing Examiner's findings, cancelled most uses of DDT on agricultural crops effective December 31, 1972. However, the cancellation for uses of DDT by public health officials in disease control programs, and by the U.S. Department of Agriculture and the military for health quarantine was lifted.

In his findings regarding the toxicological effects of DDT, the Administrator largely came to the same conclusions as the International Agency for Research on Cancer's Working Group more than 1 year later, as summarized above (page 184). However, the Administrator went beyond the cancer experts' subsequent findings in one important respect; he stated that responsible scientists believe tumor induction in mice to be a valid warning of possible carcinogenic properties and concluded that DDT presents a carcinogenic risk.

It is important to note that despite this finding, the Administrator determined, in line with WHO, the National Academy of Sciences, and others, that in public health uses, the benefits of DDT outweigh actual and potential risks.

U.S. Agency for International Development--

In compliance with its mandates from the U.S. Congress, AID has been an active participant in the worldwide campaign against malaria for many years by supporting multilateral efforts, especially those of

WHO, and by bilateral support of individual countries' antimalaria programs. To date, the Agency has thus contributed importantly to the results achieved in the global fight against malaria.

Based on the evidence summarized in the preceding sections of this chapter concerning the performance of DDT in antimalaria programs, including efficacy, safety to humans, unintended secondary effects, and cost effectiveness, and considering the current availability and performance of alternatives, it is AID's conclusion that DDT continues to be necessary and useful in antimalaria programs where vector resistance or other factors do not contraindicate its use. In arriving at this conclusion, AID has taken into account that three prestigious organizations (i.e., the World Health Organization, the National Academy of Sciences, and the U.S. Environmental Protection Agency) have recently and independently performed comprehensive evaluations of the benefits and risks associated with the use of DDT against disease vectors in the public health field. All three arrived at the same conclusion, i.e., that the benefits of the use of DDT in vector control programs outweigh actual and potential risks to the health of man and his environment.

Therefore, current and anticipated future AID pest management activities include provision for continued financing of DDT for antimalaria programs, and AID plans to continue to assist WHO and national governments of less developed countries in their efforts to reduce, control or eradicate malaria. AID also plans to continue vigorously its support of the search for, and development of alternative methods of malaria and malaria vector control, and of integrated systems for malaria control or eradication, as reviewed in Chapters I (page 74) and II (page 157) of this EIS.

As in the past, these policies and plans will be carried out within the framework of AID's overall policies, objectives, and priorities and will be subject to all applicable AID rules and regulations. In addition, they will be subject to continuous review and reappraisal, and to change, if and when new facts or information so dictate.

Some examples of past, present, and planned future AID efforts to reevaluate and improve existing programs and to stimulate the development of better methods of combatting malaria include:

* AID's periodic audits of all of its antimalaria activities (Appendix F, Vol. II of this EIS).

* The AID-funded research projects aimed at the development of a malaria vaccine, biodegradable DDT analogs, and genetic mosquito control methods (page 74).

* The identification and description of different approaches to malaria vector control through an AID-initiated and -funded study carried out by the National Academy of Sciences in 1973 (page 76).

* The proposed workshop on priorities in malaria research (page 334).

* The proposed demonstration project "Self Help Malaria Control" in Africa (page 75).

OTHER PEST MANAGEMENT PROGRAMS

Other pest management programs include all other areas of pest management except for food production-preservation and public health programs. Potential examples of other programs in pest management would be those associated with the production of nonfood crops. No pest management activities in the other pest management program areas are included in the current and anticipated AID pest management program through FY 1978.

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CHAPTER III

ALTERNATIVES FOR THE AID PEST MANAGEMENT PROGRAM

INTRODUCTION

AID's presently identified pest management program (through CY 1978), as described in Chapter II, covers a wide range of activities being conducted in over 50 less developed countries in Africa, Latin America, Asia, and the Near East. These pest management activities include training and technical assistance, research, pesticide activities,* and other pest management activities.** In addition, a number of research and training activities are being conducted in the United States.

Although AID is involved in a multitude of activities in numerous locations, all of the presently identified pest management activities are associated with either the production and preservation of food, or improvements in public health. No "other" pest management activities, such as those associated with nonfood crop production, maintenance of rights-of-way, etc., are included in AID's currently identified pest management program. However, such activities may be undertaken on request of one or more country, particularly as they relate to nonfood crop agricultural production to increase agricultural export earnings, an increase which, under some conditions, may be a necessary prerequisite to overall national development plans.

As part of this environmental impact analysis, a set of alternatives for the future AID pest management program has been selected, based on the currently identified pest management activities. The major emphasis in selection of the alternatives for analysis was given to the variation of pesticide activity. This approach was felt to be most appropriate not only

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* Pesticide activity is defined to include all activities conducted, supported, financed, or otherwise assisted by AID for the procurement or use of pesticides, but does not include pesticide research and pesticide regulatory activities.

** Other pest management activity includes those pest management projects being conducted within less developed countries that do not involve pesticide activities, such as land clearing or the draining of swamps in order to control vectors of human disease.

because the use of pesticides (pesticide activity) has the greatest potential for environmental impact of all the elements of a pest management program; but also to be responsive to the "reasonable alternatives" specified in the recent litigation (1) (see Appendix E) that resulted in the development of this document.

These alternatives for AID's future pest management program are described in the latter portion of this chapter, and their environmental impacts are discussed in Chapter IV. The results of the environmental impact analysis conducted in Chapter IV are then used as the bases for determining the best overall program for AID's currently identified pest management activities (Chapter V) as judged by their impact in promoting overall environmental quality in the long term and minimizing adverse environmental impacts in reaching short-term goals. Integration of the findings from the analyses conducted in Chapters IV and V into the AID strategy and program for future pest management activities is given in Chapter VI.

ALTERNATIVE SELECTION AND ENVIRONMENTAL EVALUATION

Five policy alternatives for future programs have been developed for use in assessing the environmental effects of AID's currently identified pest management programs. Inherent in each of these alternative approaches is the application of integrated pest management concepts to all four program elements, i.e., pesticide activities, training and technical assistance, research, and other pest management activities.

The general requirements of the new AID Environmental Procedures (Regulation 16) became effective on June 28, 1976, and would apply to all future AID pest management activities, irrespective of the specific alternative selected. These procedures ensure that an assessment of the environmental effects will be an integral part of the AID decision making process. Within the framework of this regulation, future AID activities will be conducted such that the environmental consequences of all proposed activities are identified and considered by AID and the host country, and that the indigenous capability of the less developed country to evaluate potential environmental effects as well as to implement effective environmental protection measures will be strengthened.

The requirements of these Environmental Procedures are contained in their entirety in Appendix C. Briefly stated, however, this regulation incorporates environmental considerations into the established AID procedures for initiating and funding project or program activity. The following definitions briefly describe six internal AID documents used in the review process for project activities and nonproject commodity import programs, respectively:

Projects

Project Identification Document (PID). An internal AID document which initially identifies a proposed project and contains enough information on the project to demonstrate its relevance to Agency priorities and its practical potential.

Project Review Paper (PRP). An internal AID document presented during the analytical stage of a project that identifies major project issues and assures that necessary steps can be agreed upon to examine if the project is feasible and to determine the best possible implementation plan for the project.

Project Paper (PP). An internal AID document which provides a definitive description and appraisal of the project and particularly the plan of implementation. Project Papers form the basis for a final decision on whether or not to offer AID funding for a project.

Nonproject Commodity Import Programs

Program Assistance Initial Proposal (PAIP). An internal AID document used to initiate and identify proposed nonproject commodity import programs. It is analogous to the Project Identification Document.

Program Assistance Review Document (PARD). An internal AID document used for a more detailed review of an approved Program Assistance Initial Proposal under a nonproject commodity import program. It is analogous to the Project Review Paper and contains a section which identifies categories of commodities and provides the justification for the proposed AID financing.

Program Assistance Approval Document (PAAD). An internal AID document approving nonproject commodity import program assistance. It is analogous to the Project Paper.

The new Environmental Procedures are applicable to the development and implementation of all AID projects or program actions.

Initial Environmental Examination

An Initial Environmental Examination is the initial study of the reasonably foreseeable effects of a proposed action on the human environment. Its function is to provide the basis for a Threshold Decision as to whether additional evaluation (an Environmental Assessment or an Environmental Impact Statement) will be required. If an Environmental Assessment or an Environmental Impact Statement is required, the Examination will also provide the basis for its preparation. The Initial Environmental Examination should identify and describe where appropriate: (a) the nature, scope and magnitude of any reasonably foreseeable effects of an action or any part of an action on the human environment; (b) the reasonably foreseeable effects of any such environmental impact on organisms in the biosphere including human

life; and (c) where an Environmental Assessment or an Environmental Impact Statement is required, reasonable alternatives to the proposed action, which will be studied in detail. The Initial Environmental Examination will be an integral part of the Project Review Paper or equivalent document which will be circulated to selected Federal agencies for comment, when an Environmental Assessment is to be prepared.

Threshold Decision

A formal Agency decision will then be made, based on an Initial Environmental Examination, as to whether a proposed action is or is not an action which will have a significant effect on the human environment, and, if it is, whether an Environmental Assessment or an Environmental Impact Statement is required. Actions considered in determining "significant effects" include those which adversely affect such aspects of the human environment as air, water, land, flora and fauna, and socioeconomic conditions.

This decision is made in the very early stages of activity conception, even before the activity is reviewed for consistency with AID objectives and recipient requests.

Negative Determination

A Negative Determination is a formal written document based on a Threshold Decision that a proposed action is not a major action which will have a significant effect on the human environment. A proposed activity for which a Negative Determination has been made will not require an Environmental Impact Statement or an Environmental Assessment.

Negative Declaration

A Negative Declaration is an official written Agency decision made by an Assistant Administrator which states that the Agency will not develop an Environmental Impact Statement or an Environmental Assessment for an action which the Agency has identified as being normally covered by these procedures. The decision may be based on (a) overriding considerations such as the provision of disaster relief; (b) the fact that a substantial number of Environmental Assessments or Environmental Impact Statements relating to similar activities have been prepared in the past; or (c) the fact that the Agency has previously decided to prepare a programmatic Statement or Assessment covering the activity in question.

Environmental Assessment (EA)

The Environmental Assessment is a detailed study of the reasonably foreseeable environmental effects, both positive and negative, of a proposed action and its reasonable alternatives carried out within or affecting specific developing countries. To the extent practicable, the Assessment will be developed in close collaboration with the host country institutions and subject to recipient country review.

Environmental Impact Statement (EIS)

The EIS is a detailed study of the reasonably foreseeable environmental impacts, both positive and negative, of a proposed AID action and its reasonable alternatives. It is a specific document having a definite format and content, as required by NEPA and as recommended by CEQ Guidelines.

These Environmental Procedures would apply equally to all possible alternates for future pest management activity. The five alternatives selected for evaluation represent variations in the pesticide activity components of AID's program ranging from (a) implementation of the currently identified pest management program under regulations and restrictions of the type that existed prior to the Stipulation and Court Order of December 5, 1975, which became effective in January 1976, to (b) complete elimination of pest management activities. The five alternatives are given in Table 46 and are described in the following subsection in the order of decreasing pesticide activity.

ALTERNATIVE A

This alternative represents the implementation of the currently identified AID pest management activities as they are set forth in Chapter II. All research, training and technical assistance, and other project activities would be accomplished as originally conceived. The specific active ingredient (pesticide) to be used in each pesticide activity would be controlled by AID regulations and procurement methods as they existed immediately prior to the Stipulation and Court Order of December 5, 1975 (1), i.e., AID Handbook 15 (2) as discussed in Chapter I (see page 14).

Alternative A will provide the baseline of activity and environmental impacts with which the effects of the other four alternatives will be compared.

ALTERNATIVE B

For Alternative B, pesticide activity for all parts of the overall AID pest management program will also be subjected to a specific additional evaluation which will consider the potential benefits, costs, and human and environmental risks involved in the pesticides' use. This specific evaluation of the use of pesticides will be incorporated in the overall assessment of the proposed project or program activity required by the Environmental Procedures. No pesticides will be supplied on the basis of a commodity eligibility listing as in the past.

Any proposed addition of pesticides to a project after completion of the IEE, EA or EIS will require re-evaluation in accordance with the Regulation 16 procedures.

Table 46: Alternatives for the AID Pest Management Program

Alternative	Program Elements	Regulatory Restrictions
A	Pesticide Activities,[a] Training/Technical Assistance, Research, and Other Pest Management Activities as described for the currently identified AID Pest Management Program (see Chapter II)	AID Regulations[b] Plus AID Environmental Procedures (Regulation No. 16)[c]
B	"Modified" Pesticide Activities; with full Training/Technical Assistance, Research, and Other Pest Management Activities	Regulation No. 16,[c] AID Regulations,[d] plus risk-benefit analysis of each pesticide activity
C	"Restricted" Pesticide Activities; with full Training/Technical Assistance, Research, and Other Pest Management Activities	Regulation No. 16,[c] AID Regulations,[d] plus the restrictions of the Stipulation and Court Order of December 5, 1975
D	No pesticide activities; with full Training/Technical Assistance, Research, and Other Pest Management Activities	Regulation No. 16[c]
E	No pest management program	Regulation No. 16[c]

a/ Pesticide activity is defined as all activities conducted, supported, financed, or otherwise assisted by AID which includes the procurement or use of pesticides, but does not include pesticide research and pesticide regulatory activities.

b/ AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975.

c/ Federal Register, 41(127):26913-26919, June 30, 1976 (Appendix C).

d/ The same regulatory restrictions set forth in b/, except that use of the historical commodity eligibility list for pesticides would not apply.

The initial step in the specific evaluation of pesticide activities under Alternative B will be the determination of the current regulatory status of the pesticide as established by the U.S. Environmental Protection Agency. The scope and depth of the evaluation required for the approval of a given pesticide in any AID activity will be governed by its current regulatory status. The potential status of candidate pesticides in terms of their EPA regulatory status and the required Regulation 16 review requirements are shown in Table 47.

Except for emergency situations, the use of a given pesticide as part of any AID activity will require the previous submission of data to AID/W demonstrating a history of both its efficacy and safety for the intended use in the LDC. Where documentation is not available, initial AID pest management activity in the proposed project or program will focus on the development of such efficacy and safety data prior to any decision on procurement or use.

The evaluation of the risks and benefits associated with the uses of particular pesticides, taking into consideration their current regulatory status as established by EPA, will be integrated with and made a part of the project development process as outlined on page 211 and the Environmental Procedures as outlined on page 212.

In general AID will encourage countries requesting pesticides to select pesticides from those in Category 2(a) and only when no suitable pesticides can be identified in this category, will consideration be given to the use of pesticides in Categories 2(b) through 2(i).

Regulations to be promulgated after the filing of this Environmental Impact Statement will prescribe the scope and depth of the risk/benefit assessments which will be required for each pesticide category in Table 47 and, where appropriate, the necessity for also providing a technical assistance component in each project to ensure that the requested pesticides are used safely and effectively.

ALTERNATIVE C

This alternative represents continued conduct of pesticide activities as has been done since the Stipulation and Court Order of December 5, 1975 (1). Specifically, this alternative would continue the Stipulation requirement that AID:

". . . not provide assistance for the procurement and use of--

(1) dichlorodiphenyl trichloroethane (DDT) (except for public health use)
(2) aldrin and dieldrin (except for restricted termite use, the dipping of roots and tops of nonfood plants)
(3) 2,4,5-T
(4) chlordane
(5) heptachlor

Table 47: Classification of Candidate Pesticides for Specific Evaluation

Categorization in Terms of Proposed Use and U.S. EPA Regulatory Status	Review Requirements in Accordance with AID Regulation 16, 22 CFR Part 216
1. Pesticide to be used for research or limited field evaluation purposes only, irrespective of its current United States regulatory status.	IEE[b]
2. Projects involving demonstration or use of pesticides for specified uses:	
(a) Pesticide registered for same or similar uses[a] in the United States without restrictions.	IEE[b]
(b) Pesticide registered for same or similar uses[a] in United States, restricted on basis of user hazard.	IEE and, if approved, user hazard warning to and certification of awareness from LDC.[b]
(c) Pesticide registered for same or similar uses[a] in United States, restricted on basis of environmental hazard.	IEE plus EA or EIS[c]
(d) Pesticide registered for same or similar uses[a] but currently under presumption against reregistration, notice of intent to cancel or subsequent notice of intent to suspend issued by EPA.	IEE plus EA or EIS,[c] and, if approved, notice of impending action to LDC.
(e) Pesticide previously registered for same or similar uses[a] but cancelled for environmental hazard.	IEE plus EA or EIS[c]
(f) Pesticide previously registered for same or similar[a] uses but cancelled for health reasons.	IEE plus EA or EIS[c] and, if approved, health warning to and certification of awareness from LDC

Table 47 (Concluded): Classification of Candidate Pesticides for Specific Evaluation

Categorization in Terms of Proposed Use and U.S. EPA Regulatory Status	Review Requirements in Accordance with AID Regulation 16, 22 CFR Part 216
(g) Pesticide registered for a different use in United States.	IEE plus EA or EIS[c/]
(h) Pesticide not registered for any use in United States, but tolerances established.	IEE plus EA or EIS[c/]
(i) Pesticide not registered for any use in United States, no tolerances established.	IEE plus EIS[c/]

a/ Similar use is defined to include the use of a substantially similar formulation in a comparable use pattern. The term use pattern includes target pest, crop or animals treated, application site, and application technique, rate, and frequency.

b/ Pesticides in this category will not ordinarily be subject to further analysis, however, the decision to undertake such analysis will be made on a case-by-case basis.

c/ Pesticides in this category will, following the Initial Environmental Examination, automatically trigger an Environmental Assessment as a minimum or an Environmental Impact Statement, the choice of which will continue to be governed by AID Regulation 16.

"and will not provide assistance for a pesticide which is not registered, for a use which is not registered, for a pesticide or a use which has been finally suspended, or for a use or pesticide which has been cancelled by the EPA." (The complete text of the Stipulation is given in Appendix E.)

All pesticide activities would be regulated by these requirements, as well as previous AID regulations (2) and the new Regulation 16 (3).

As was discussed in Chapter II (page 110), because United States registrations are for use against specific pests, few of which occur in LDC's, the procedure required by the Stipulation has caused an increased awareness on the part of the Agency to the extent that until the present (April 1, 1977) the use of the complete procedure has not been necessary. Numerous requests, most notably from Africa, have been denied because of the stringent conditions of the Stipulation.

ALTERNATIVE D

This alternative includes the complete elimination of all pesticide activities from all AID pest management activities. Research, training and technical assistance, and other pest management activities would be unchanged from Alternative A.

ALTERNATIVE E

This alternative represents the elimination of all elements of pest management activity from AID's development and security supporting assistance programs. Future fiscal commitments in the area of pest management would be cancelled, and ongoing projects and program activities would be summarily terminated.

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CHAPTER IV

ENVIRONMENTAL IMPACTS OF ALTERNATIVE AID PEST MANAGEMENT PROGRAMS

This chapter contains an analysis of the potential environmental impacts associated with AID's pest management program that has been identified through CY 1978. Five alternative pest management programs have been described in Chapter III that cover the complete range of potential pesticide activity,* i.e., the aspect of AID's pest management program that has the most significant environmental consequences. In this chapter, each of these five alternatives has been evaluated for the two major areas of AID's proposed pest management program, i.e., public health, and food production and preservation, as described in Chapter II.

The programmatic environmental impact analysis discussed in this chapter is divided into three major sections. The first section describes the general impacts of pest management activities in public health and food production-preservation programs. The general impacts of pest management activities on human health, the environment, and socioeconomic aspects are discussed for recipient regions and countries, as well as impacts on the United States and extraterritorial global areas. The second section of the chapter presents analyses of the impacts of the five alternatives for AID public health programs, and food production and preservation programs, respectively. Impacts of the various alternative programs are compared to those of Alternative A, the currently identified pest management program as described in Chapter II, for each of the two program areas. Thus, the impacts of Alternative A are treated as the baseline against which the impacts of the other alternatives are compared. The third section of the chapter presents a synopsis of the potential impacts of the various alternatives by program area, for the less developed countries, the United States, and extraterritorial global regions.

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* Pesticide activity is defined to include all activities conducted, supported, financed, or otherwise assigned by AID for the procurement or use of pesticides, but does not include pesticide research and pesticide regulatory activities.

GENERAL IMPACTS OF PEST MANAGEMENT PROGRAMS

Controlling crop losses and disease vectors is an integral part of development programs in LDC's, and effective pest management activities can have a substantial impact on this development activity. It is important to understand, however, that the general impacts discussed in this section are those which are attributable to pest management activities in LDC's, and that the United States, through AID, is only one of many national and international organizations that contribute to overall development programs in these countries. AID pest management activities are only one small element in the overall development program. Consequently, it is not possible in many cases to factor out that portion of potential benefits or disbenefits directly attributable to AID pest management activities.

The following discussion of general impacts is divided into four subsections: (a) Impacts of Public Health Programs; (b) Impacts of Food Production and Preservation Programs; (c) Impacts of Research Activities; and (d) Impacts of Training and Technical Assistance. Each of these subsections presents the major general impacts associated with pest management activities. The general impacts set forth here are those which are considered throughout the remainder of this chapter when discussing specific consequences of alternative AID pest management programs.

Impacts of Public Health Programs

AID-financed public health programs in LDC's which involve pesticide activities are specifically aimed at reducing the incidence of endemic human diseases and their ramifications through the control of disease vectors. The major general impacts of these programs on human health, the environment, and the socioeconomic status of the recipient countries are shown in Table 48. This table further divides the socioeconomic impacts into three categories: economics, agriculture, and social organization.

The impacts shown in Table 48 are the ones which are addressed in this chapter when discussing the specific health, environmental, and socioeconomic effects of AID-financed pesticide activities on the recipient countries. Subsequent discussions also include extraterritorial global and U.S. impacts, short-term benefits versus long-term effects, unavoidable adverse effects, and irreversible and irretrievable commitments of resources of the AID programs.

Table 48: General Impacts of Pest Management Activities for Public Health Programs

Areas of Impact	Anticipated Benefits	Potential Disbenefits
HUMAN HEALTH	Decrease in the number of deaths and illnesses caused by debilitating, endemic diseases, including decrease in the infant mortality rate. Increase in life expectancy, and in the overall quality of health. Increase in availability of critical medical services due to reduced incidence of endemic disease.	Adverse effects on people resulting from direct occupational or nonoccupational exposure to pesticides, or from exposure to residues in food, air, house dust, and drinking water. Increase in the resistance of disease vectors to pesticides.
ENVIRONMENT	Potential reduction of certain diseases of mammalian wildlife (e.g., trypanosomiasis).	Disruption or loss of wildlife habitat due to vector control activities (e.g., wetland draining) and expanded areas of agricultural activity. Pesticide residues in air, water, and soil. Adverse effects on flora and fauna exposed to pesticides.
ECONOMICS	Increase in overall labor productivity due to improved general health. Potential positive impacts on individual income, overall employment level, GNP, and overall economic activity resulting from improved general health.	Increase in the cost of pesticide activity due to pesticide resistance. Increase in the requirements for many basic services due to increasing life expectancy.
AGRICULTURE	Potential increase in agricultural production and productivity and food supply due to increases in habitable land and improved health of the workers. Prevention of disease of domestic animals, e.g., fascioliasis.	Increase in the resistance of agricultural pests from public health uses of pesticides.
SOCIAL ORGANIZATION	Increase in habitable land areas. Increase in overall social well-being due to improved level of general health and economic activity. Potential improvement of literacy rate.	

Human Health Impacts--

Since the primary thrust of AID-supported public health programs is the reduction of human disease and its ramifications, the primary beneficial impact of successful programs would be to decrease the number of deaths and illnesses caused by debilitating, endemic diseases. Other beneficial impacts of major importance that are anticipated to occur as a result of disease reduction would include a decrease in the infant mortality rate, an increase in life expectancy, an increase in the overall quality of health, and an increase in the availability of critical medical services. These impacts would occur within the recipient LDC.

Pesticide activities conducted in AID pest management activities for public health would also have the potential for creating negative impacts (disbenefits) within the recipient countries. The potential major negative impacts would result from human exposure to persistent and toxic pesticides, and from the development of resistance to pesticides in disease vectors.

The three major problems encountered in using pesticides for the control of disease vectors of public health significance--pesticide persistence, pest resistance, and human pesticide poisoning--occur to varying degrees depending upon the pesticide used. The pesticides of importance which AID anticipates using in its current and projected public health program are DDT, malathion, Abate®, and BHC. In addition, a number of other pesticides are being considered for possible use in public health programs in Africa and elsewhere. These include niclosamide, N-trityl morpholine, and sodium pentachlorophenate for programs to control schistosomiasis, and chlorphoxim or micro-encapsulated methyl-Dursban® for onchocerciasis control if resistance to Abate® develops. The characteristics of DDT, malathion, Abate®, and BHC, which give them the potential for causing the above-mentioned problems are discussed in the data profiles provided in Appendix B. These profiles serve as a basis from which anticipated health impacts of AID-proposed activities are discussed in this chapter.

Pesticide persistence--DDT and BHC are persistent pesticides and can remain as a residue for years, while Abate® and malathion are relatively nonpersistent. Applications of DDT and BHC to dwellings in malaria control programs exposes the inhabitants to these pesticides for long periods. Since EPA has designated DDT as a potential human carcinogen and lindane (the gamma isomer of benzene hexachloride which constitutes about 40% of BHC) has been shown to be carcinogenic in mice, humans chronically exposed to these chemicals may suffer adverse effects in the long run.

Pest resistance--The problem of resistance is of special importance because it poses potential technological limitations on the effectiveness of the pesticide activity component of pest control programs. Because natural populations of most species contain a considerable diversity in genetic makeup, not all members of the population have the same susceptibility to chemical or biological hazards in their environments--whether they be pesticides, therapeutic drugs or pathogens. Hence, in populations of sufficient genetic diversity, the less susceptible members survive exposure to an otherwise effective level of a given toxic chemical and reproduce. If the reproduction rate is very rapid, as is the case with many insects (such as mosquitoes and flies), the natural population may soon contain a large proportion of members that are resistant to that chemical.

There are no completely satisfactory drugs for use in treating onchocerciasis, and drugs for schistosomiasis are less than ideal. Hence, in controlling vector-borne diseases, it is necessary to integrate the use of pesticides with other efforts such as chemoprophylaxis, curative drug therapy, good epidemiological surveillance, education, and where appropriate, engineering measures in order to accomplish effective disease and vector control.

A program which employs only one of the above measures in an attempt to control the disease risks diminishing results through the emergence of natural adaptive mechanisms. The extent of integration of several measures into a plan to control a vector-borne disease provides a general indication of the level of success to be expected from implementing the plan.

Human pesticide poisoning--The potential problem of human pesticide poisoning through occupational exposure of pesticide applicators in LDC's is a serious one. Untrained and unskilled applicators are often exposed to serious risks when handling and applying a toxic pesticide to homes in malaria control programs, and expose not only themselves, but the inhabitants as well. The episode which occurred when using malathion in Pakistan is a good example of this problem (1).

The Pakistan Malaria Program first used malathion (long considered in the United States to be one of the safer pesticides) on a wide scale in 1976. Most of the usage was in two provinces: Punjab and the Northwest Frontier. Spraying was begun in June or July, depending upon pesticide availability and was scheduled to continue for 3 to 4 months. The malathion was provided by three formulators--American Cyanamid, Snia Viscosa (Italy), and Rumianca (Italy)--and was used in the form of a 50% water dispersible powder which was mixed with water at the site of application and applied to room walls, roof, and eaves with hand compression sprayers. Approximately 7,490 workers were involved in the field spraying operations in these two provinces; 1,070 field supervisors; 1,070 mixers and 5,350 spraymen.

The spray teams, each consisting of five spraymen, one mixer and one field supervisor, were composed of village men, mostly without formal education, ages 14 through 60, many of whom had previous experience with spraying DDT and BHC in other programs. Training of the spraymen and mixers was the responsibility of the local field supervisor and focused primarily on operational methods, such as mixing and spraying techniques, with little attention given to safety methods.

Cases of pesticide intoxication were observed within a few days of the start of spraying operations. The symptoms and clinical histories of the affected workers were consistent with organophosphate insecticide intoxication; subsequent data on cholinesterase levels confirmed this diagnosis. Treatment of the cases was handled inadequately in the early stages. Later, atropine was made available through the Malaria Program and use of this drug undoubtedly prevented many severe illnesses and probably some deaths. Still, there were five deaths among spraymen which were probably related to insecticide poisoning.

Three studies were conducted to evaluate the extent and causes of this epidemic of insecticide intoxication. First, a retrospective survey was conducted to obtain an estimate of the number of illnesses which had occurred during July 1976. This survey involved interviewing 331 spraymen, 66 mixers, and 75 field supervisors in the two provinces to determine whether they experienced symptoms of malathion intoxication, defined as at least one episode characterized by four of the following symptoms: blurred vision, giddiness, nausea, vomiting, or abdominal cramps. Based on this definition, 16% of supervisors, 35% of mixers and 45% of spraymen experienced at least one episode of malathion intoxication during July 1976.

Second, a field study was conducted to assess the relative toxicities of the malathion in the three formulations being used in Pakistan and to determine if poor work practices could be related to signs of pesticide toxicity. The study consisted of observing workers during a typical work day, testing blood samples of the workers for cholinesterase levels, interviewing workers at day's end to determine if they had developed any symptoms of pesticide toxicity during the day, and testing malathion samples used by each spray team to determine the amounts of malathion, isomalathion, and minor components present. One hundred four workers using Cyanamid malathion, 27 workers using Rumianca malathion, and 36 workers using Snia Viscosa malathion were tested. The results were: plasma and red cell cholinesterase levels were lowest in spraymen who used Snia Viscosa malathion; cholinesterase depression was associated with symptoms consistent with pesticide intoxication in the workers. Mean cholinesterase levels of workers with poor work habits were not significantly different from those who practiced good work habits. Comparison of the toxicity analyses showed a correlation between levels of isomalathion contamination and depression of cholinesterase levels or symptoms of pesticide intoxication in the workers.

Third, an environmental study was conducted by an industrial hygienist from NIOSH. Air sampling and skin patch testing of individual spraymen were performed to evaluate respiratory and dermal exposures to malathion. Air sampling was performed in rooms sprayed with malathion. Results of this study, however, were not available at the time of this writing.

This epidemic represents the first report of significant illness among workers exposed to malathion. Numerous studies of pesticide plant employees, agricultural workers, and spraymen in malaria programs have not shown significant toxicity following malathion exposure. Although some of the cases reported here were attributable to the use of contaminated malathion supplied by the Italian firms, symptoms were also reported by workers exposed to malathion manufactured by Cyanamid. The major contributing factors in these cases appear to have been poor work practices, including mixing of the pesticide by hand, not washing pesticide-contaminated clothing, eating pesticide-contaminated food, failing to adequately cover the skin during spraying, and the use of two brands of malathion (both Italian) containing contaminants which rendered them excessively toxic. This situation resulted in the development of more rigid specifications for malathion to be used in future malaria control efforts receiving AID support. These new specifications were developed by AID in consultation with the CDC and WHO.

Environmental Impacts--

Pesticides used in public health programs have at least one major potential beneficial environmental impact, and that is the reduction of certain public health diseases which also afflict mammalian wildlife (e.g., trypanosomiasis and snail-transmitted diseases). These programs also benefit domestic animals, e.g., cattle and sheep. In general, however, pesticides do have a potential for creating adverse environmental effects. To assess the environmental significance of pesticide use, one must first consider the specific properties of the pesticides that are important in affecting both the living and physical environment. The most important properties for such an assessment are: acute and chronic toxicity to wildlife; environmental persistence; bioaccumulation and biomagnification; and physical properties, such as volatility, leachability and physical form, which affect the transport, transformation, accumulation, and fate of the pesticide in the physical environment. Second, one must consider the method of application of the pesticides. Applications to dwellings are much less apt to contaminate the environment than larviciding drainage ditches and waterways.

Use of insecticides in public health programs has the potential for creating two major negative impacts on the environment. First, the living environment of flora and fauna, including beneficial insects, may be exposed to the insecticides and suffer adverse effects as a result. Second, pollution of the air, water, and soil of the physical environment by pesticide residues may result.

An additional impact that may result would be the disruption or loss of wildlife habitats due to the expansion of agricultural activity into areas freed from disease that were formerly uninhabitable by man.

The general effects on wildlife of pesticides identified for use in AID-financed public health programs are shown in Table 49. Other important properties of these four insecticides which affect their environmental fate, and thus, their impacts on the environment, are given in detail in Appendix B.

Socioeconomic Impacts--

The subject of socioeconomic impacts of pesticide management activities in LDC's must be viewed in its totality. These impacts consist of a web of effects which in turn cause other secondary webs of effects, and encompass a wide and diverse range of activities in even the smallest and least developed country. The major general impacts of public health pesticide activities in LDC's, both benefits and disbenefits, are set forth in Table 48 in the areas of economics, agriculture, and social organization.

Extraterritorial Global and United States Impacts--

AID pest management activities in LDC's may have impacts on the extraterritorial global waters and atmosphere, and migratory wildlife, as well as on health, environment and socioeconomic conditions in the United States. The impacts on these areas that can be attributed to AID, however, are very minor, for reasons discussed subsequently in this chapter. These impacts are discussed in this chapter under both public health programs and food production and preservation programs.

The potential impacts for these two geographical areas are: pesticide residues in global waters and air; exposure of migratory wildlife to pesticides and disruption of migratory patterns due to habitat modification; occupational exposure of U.S. pesticide workers who produce or transport AID-financed pesticides; exposure of segments of the general U.S. population to foodstuffs contaminated with pesticide residues imported from LDC's, and exposure of the U.S. population to AID-financed pesticides in air and water; and socioeconomic effects of the purchase of AID-financed pesticides on the U.S. pesticide industry and general economy.

Short-Term Benefits Versus Long-Term Effects--

There are two primary considerations regarding short-term health benefits versus long-term negative effects: (a) immediate control of disease versus development of disease vector resistance; and (b) immediate disease control versus long-term human exposure to persistent pesticides in dwellings and the environment.

An additional long-term impact on the lives and habitats of wildlife indigenous to the LDC's where pesticide activities take place is possible when disease control enables man to settle in regions freed of disease and enables man to encroach on wildlife habitat.

Table 49: Toxicity of Public Health Insecticides to Wildlife[a/]

Compound	Toxicity Group	Toxicity to: Wild Mammals	Birds	Fish	Lower Aquatic	Soil Organisms	Degraded by: Biological Organisms	Nonbiological Organisms	Sunlight	Degradation Rate	Bioconcentrated in Food Chain
Abate®	-	Relatively nontoxic	Relatively nontoxic	Relatively nontoxic	Slightly toxic	Relatively nontoxic	Insignificant	Insignificant	Insignificant	Rapid	Not likely
BHC	II, moderately toxic	Moderately toxic	Slightly toxic	Highly toxic	Highly toxic	Slightly to relatively nontoxic	Not known	Not known	Not known	Very slow	Not known
DDT	II, moderately toxic	Moderately toxic	Moderately toxic	Highly toxic	Toxic	Slightly toxic	Yes	Yes	Yes	Very slow	Yes
Malathion	III, slightly toxic	Relatively nontoxic	Moderately toxic	Highly toxic	Moderately toxic	Toxic only to soil insects	Yes	Yes	Yes	Rapid	No

a/ Source: Based on data in Appendix B.

Unavoidable Adverse Effects--

The most important unavoidable adverse effects of AID public health pesticide activities in LDC's are (a) the human health and socioeconomic effects of disease-vector resistance to pesticides; and (b) the occupational exposure of pesticide spraymen and nonoccupational exposure of inhabitants of the dwellings to which the pesticides are applied.

Irreversible and Irretrievable Commitment of Resources--

Resources such as petroleum, energy, and manpower are irreversibly and irretrievably committed when used to manufacture, transport, and apply AID-financed pesticides. Wildlife resources are irreversibly lost if habitat is lost due to pesticide activities. These two commitments, one intentional and the other unintentional, are considered in this study.

Impacts of Food Production and Preservation Programs

AID-financed food production and preservation programs in LDC's which involve pesticide activities are specifically aimed at increasing agricultural productivity through the control of destructive agricultural crop pests. The major general impacts of these programs on human health, the environment, and the socioeconomic status of the recipient countries are shown in Table 50. This table further divides the socioeconomic impacts into three categories: economics, agriculture, and social organization.

The impacts shown in Table 50 are the ones which are addressed in this chapter when discussing the specific health, environmental, and socioeconomic effects of AID-financed pesticide activities. Subsequent discussions also include extraterritorial global and U.S. impacts, short-term benefits versus long-term effects, unavoidable adverse effects, and irreversible and irretrievable commitments of resources of the AID programs.

Human Health Impacts--

Since the primary thrust of AID-supported food production and preservation programs is to increase the agricultural productivity in LDC's through increased food production, the primary beneficial impact of successful programs would be to raise the average nutritional level of the generally undernourished population of the LDC's. Other beneficial impacts of major importance that are anticipated to occur as a result of increased nutrition would include a decrease in infant mortality rates, an increase in life expectancy, an increase in the overall quality of health, and an increase in the availability of critical medical services. These impacts would occur within the recipient LDC's.

Table 50: General Impacts of Pest Management Activities for Food Production and Preservation Programs

Areas of Impact	Anticipated Benefits	Potential Disbenefits
HUMAN HEALTH	Increase in the average nutrition level and the overall quality of health due to the improved availability of food and feedstuffs. Increase in availability of critical medical services due to the improved level of general health. Decrease in morbidity and mortality, including infant mortality. Increases in life expectancy due to improved nutrition. Decrease in disability.	Adverse effects on people resulting from direct occupational or nonoccupational exposure to pesticides, or from exposure to residues in food, air, and drinking water. Increase in the resistance of certain disease vectors to some pesticides.
ENVIRONMENT		Disruption or loss of wildlife habitat due to expanded areas of agricultural activity. Pesticide residues in water, air, soil, and nontarget biota. Adverse effects on nontarget flora and fauna including beneficial insects exposed to pesticides.
ECONOMICS	Increase in crop and livestock production and agricultural productivity, with potential increase in exports. Potential increase in productive land area, income to farmers, GNP, and general economic activity.	Increase of secondary pests to economically significant levels because of shifts in insect populations. Potential problems from pesticide residues in export crops, resulting primarily from misuse or misapplication of pesticides. Increase in the requirements for many basic services due to increasing life expectancy.
AGRICULTURE	Increase in overall agricultural production and productivity.	Increase in the resistance of target pests to pesticides. Increase in demand for food due to population increases.
SOCIAL ORGANIZATION	Increase in overall social well-being due to improved nutritional level.	

Pesticide activities conducted in AID agricultural pest management programs would also have the potential for creating negative impacts within the LDC's. The potential major negative human health impacts would be increasing pesticide resistance in disease vectors and agricultural pests; exposing segments of the general population to pesticides directly through residues in food, air, and water; and exposing agricultural workers to pesticides.

The pesticides that have been identified for possible use in currently identified AID agricultural programs are shown in Table 51. Each of these pesticides varies from the others in its acute toxicity, chronic health effects, persistence, environmental fate, and occurrence as a food residue, as discussed in detail in Appendix B. Those properties are discussed more fully later in this chapter with particular emphasis given to the hazardous effects of direct agricultural worker exposure to these pesticides and to the problem of pesticide residues on food.

Table 51: Potential Pesticides to Be Used in the AID Food Production and Preservation Programs

<u>Insecticides</u>
Chlorinated hydrocarbons
• BHC
• endosulfan
Organophosphates
• monocrotophos
• oxydemeton-methyl
• parathion
• trichlorfon
Carbamates
• carbaryl
<u>Herbicides</u>
• alachlor
• atrazine
• cyanazine
• linuron

The problem of pest resistance in agriculture is of special importance because it poses potential technological limitations on the effectiveness of agricultural pest control programs; potential impacts are analogous to those previously discussed for the public health program.

Environmental Impacts--

Pesticides used in agricultural programs have no major potential beneficial environmental impacts and two potential major negative environmental impacts. First, the living environment of beneficial flora and fauna may be exposed to the pesticides, and suffer adverse effects as a result. Second, pollution of the air, water, and soil of the physical environment by agricultural pesticide residues may result.

To assess the environmental significance of agricultural pesticide use, one must consider the specific properties of the pesticides that are important in affecting both the living and physical environment. These properties are discussed in detail in Appendix B for the 11 pesticides identified for possible use in agricultural programs in LDC's, and are taken into consideration when discussing the specific environmental impacts of agricultural pesticide usage in this chapter.

Persistent pesticides can be transported from their original point of application to other areas where they may cause acutely toxic effects on nontarget organisms or sublethal, chronic effects. Furthermore, even when such initial chronic effects are undetectable, persistent pesticides can be accumulated through the food webs to result in residues in animals at the higher trophic levels.

Although the exact routes of transportation through the environment are not well understood for all of the less developed countries, most of the persistent pesticides are organochlorines which are relatively insoluble in water but readily adsorbable on soil particles. Losses of the top layers of soil through wind and water erosion, however, are probable ways in which pesticides move from target to nontarget areas. Immediate losses during application, such as drift, overspray, and spills are also important.

It has been said that the ocean is the ultimate sink for all pesticides applied in the world. Therefore, lakes and streams are intermediate sinks and the pathways by which pesticides reach the ocean. Because of the adsorption of pesticides on sediment particles, the bottom sediments of water bodies draining areas of intensive agriculture are likely to contain detectable or even significant amounts of the persistent compounds used and the metabolites of the degradable ones.

In a well-balanced aquatic ecosystem, photosynthetic organisms play the role of primary producers while bottom organisms and zooplanktons are intermediate converters and consumers. Many of these organisms are filter-feeders and pass large volumes of water and sediment through their bodies during a

life cycle. This feeding habit, the pesticides in the sediment, and the fat-solubility of many persistent pesticides result in bioaccumulation, a process by which pesticide levels in living organisms rise to values many times that of their immediate environment. In some cases the levels of accumulated pesticides can reach threshold limits for the specific organism and death occurs. Since many of the more important freshwater bottom organisms are insect larvae, it is not uncommon for them to be more sensitive than fish to some pesticides. It is also possible for the fat reserves of some organisms to become so heavily saturated with pesticides that the organism perishes if environmental conditions require it to assimilate those reserves.

The higher trophic levels within aquatic ecosystems include both invertebrate and vertebrate predators. However, some invertebrates and vertebrates fill niches in the ecosystem as consumers of primary production. These animals are not so dependent on the bottom organisms, directly or indirectly, and are less likely to be affected by pesticide-laden sediments. Those animals which feed directly on bottom organisms alone are more likely to accumulate pesticide residues. However, some predatory fish may feed on smaller forage species which are bottom feeders and may also accumulate residues of persistent pesticides.

The probability that fish would directly absorb significant amounts of pesticides dissolved in water in natural habitats is very low. Most persistent pesticides are only slightly soluble in water and the probability that pesticides in aqueous solutions in large quantities would reach natural waters is low. However, it is possible that a large field adjacent to a small pond or stream could yield enough pesticide during a heavy rain immediately after pesticide application to produce concentrations above the threshold for some species. The situation in which fish would be most directly affected involves the culture of fish in rice paddies in Southeast Asia. Several persistent pesticides have been used to control rice stem borer and have caused losses of fish populations. Furthermore, the paddy water, when released, may convey pesticides to natural waters. Fish which survive in such areas may contain high residues.

In many developing parts of the world, fish are important sources of protein. In some parts of Southeast Asia, fish may be the only source of animal protein in the diet because of religious beliefs. Therefore, it is imperative that both the potential to produce fish and the quality of the fish produced be considered. It would be contradictory to culture or harvest fish which are unhealthful for humans. While it is known that certain organochlorine pesticides are carcinogenic to laboratory animals, it is not known that they result in similar neoplasms in humans. However, until it is proven that they do not, the safe course of action is to minimize human exposure to them.

In addition to the effects of pesticides on the fisheries of host countries, there is a potential for pesticide use in one country to affect the fishery resources of neighboring countries. In some cases, major river systems flow across entire continents, countries share large freshwater lakes, and others share saltwater estuaries and embayments. In these situations, the most probable impact of pesticide activity in pest management programs is the accumulation of pesticides in bottom sediments and the development of persistent pesticide residues in fish stocks.

Continued use of persistent pesticides in pest management programs may also contribute to the levels of pesticides found in oceanic environments. While it cannot be determined from available data what the future levels will be, it can be assumed that decreases in current levels of total use of persistent compounds would eventually allow ambient levels in the oceanic systems to decline.

Socioeconomic Impacts--

The socioeconomic impact of pesticide activities used for agricultural programs is quite complex. To make the task manageable, only the apparent major general impacts of agricultural activities in LDC's were listed; in developing this list, emphasis was given to situations as they exist in the less developed countries. These impacts, both benefits and disbenefits, are set forth in Table 50 in the areas of economics, agriculture, and social organization.

Extraterritorial Global and United States Impacts--

AID pesticide activities in LDC's may have impacts on the extraterritorial global waters, the global atmosphere, migratory wildlife, and the health, environment, and socioeconomic conditions in the United States. However, the magnitude of the impacts on these areas that can be attributed to AID are very minor for reasons given subsequently in this chapter. This topic is specifically addressed later in this chapter under both Public Health Programs and Food Production and Preservation Programs, and for both program areas, the impacts are essentially the same.

Short-Term Benefits Versus Long-Term Effects--

The short-term benefits of increased food production and increased human nutrition brought about by the control of agricultural pests are accompanied by long-term negative effects. The most important long-term negative effects are (a) the cumulative effects of human exposure to pesticides; (b) increasing agricultural pest resistance to pesticides; and (c) persistent toxic pesticide residues in the environment. Each of these effects are addressed specifically later in this chapter.

Unavoidable Adverse Effects--

The most important unavoidable adverse effects of AID-financed agricultural pesticide activities in LDC's are (a) the human health and socioeconomic effects of such resistance to pesticides as may develop; and (b)

the contamination of the physical environment with pesticides applied directly to agricultural crops or inadvertently to adjacent areas through spray drift, runoff, or erosion.

Irreversible and Irretrievable Commitment of Resources--

Resources, such as petroleum, chemicals, energy, manpower, etc., are irreversibly and irretrievably committed when used to manufacture, formulate, and apply AID-financed pesticides to agricultural crops. Agricultural expansion may irretrievably commit land to agriculture, and take the area away from the undeveloped land base of the country, rendering it unusable for other purposes. Wildlife resources may be irreversibly lost if habitat is lost due to agricultural pesticide activities.

Impacts of Research Activities

AID plans the continued support of a variety of research activities to further the development and improvement of integrated pest management techniques for use in public health, and food production and preservation programs. These programs are conducted primarily through AID-funded research contracts with United States universities and other public agencies, operating within the United States as well as overseas. In addition, AID will continue to provide partial support for 13 international agricultural research centers.

Public health research programs include developing and testing substitute chemicals and alternative pest control methods for the control of resistant disease vectors and developing nonchemical control methods in interregional programs.

Agricultural research programs include developing and testing more effective methods of utilizing pesticides on crops, developing disease- and insect-resistant varieties of grains and legumes, developing methods to control disease vectors attacking livestock, and developing chemical and physical pest management techniques to control vertebrate pests (e.g., rats, bats, and noxious birds).

Field testing is an integral part of many pesticide research programs, and the field tests are normally conducted in the LDC's. These tests involve a limited amount of pesticides applied to a small area under carefully controlled and regulated conditions. Any adverse impacts on human health and the environment attributable to such testing are generally insignificant.

The major impact of research activities is that the long-term beneficial effects of pest management activities in both public health and agriculture, as previously discussed, would be enhanced and optimized, while at the same time the magnitude of negative impacts of pesticide activities in public health and agriculture would be reduced or eliminated. All AID research in these areas is aimed at improving the efficiency and effectiveness of pest control, and where successful, will have positive influence on the impacts of pest management activities.

Impacts of Training and Technical Assistance Activities

Training and technical assistance activities are important elements in AID's pest management assistance to LDC's. AID assists these countries in training and educating the people in the proper use of pesticides, and assists in devising and implementing ecologically and economically sound integrated pest management systems for the control of disease vectors and agricultural pests.

The impact of training and technical assistance activities in LDC's will be beneficial to the human health, environment, and socioeconomic status of these countries. Training and assisting the people in LDC's will help avoid many of the problems associated with the improper use of pesticides by people relatively uninformed regarding pesticide use techniques, and at the same time will lead toward maximizing the benefits that can be obtained from the proper use of pest management techniques.

Improper use of pesticides results in three categories of wastes and losses: unnecessary use, overuse, and misuse. Training and technical assistance activities that reduce the unnecessary use and overuse of pesticides will benefit the health, environment, and economic status of the people in these countries. Needless human exposure to pesticides on food, in the air, in drinking water, and by direct contact will be avoided; the introduction of unnecessary amounts of pesticides into the environment will be avoided; and economic waste will be reduced.

In summary, research which defines proper pest management techniques, combined with training and technical assistance in LDC's that educates the people in the use of such techniques, is beneficial to the extent that the positive impacts of pest management activity will increase and the negative impacts will decrease.

IMPACTS OF AID-FINANCED PEST MANAGEMENT PROGRAMS

The impacts that AID-financed pest management activities in LDC's have upon human health, the environment, socioeconomics, extraterritorial areas and the United States, short-term benefits versus long-term effects, unavoidable adverse effects, and the irreversible and irretrievable commitment of resources are discussed in this section which is divided into two parts: public health programs, and food production and preservation programs. Each of the two programs is discussed separately since the magnitude and importance of various impacts are different for public health programs and agricultural programs due to the different uses of pesticides in each program area.

Public Health Programs

The impacts associated with each of the five alternative pest management programs for public health, described in Chapter III, are evaluated in this section. The general impacts of interregional public health program activities and research activities are discussed first. Impacts of each alternative are discussed under seven organizational headings: human health, environment, socioeconomics, extraterritorial global and U.S. impacts, short-term benefits versus long-term effects, unavoidable adverse effects, and irreversible and irretrievable commitment of resources. Specific impacts are examined for Latin America, Africa, and Asia, under Alternative A. (No public health programs involving pest management activity are currently identified for the Near East.) For Alternatives B through E, the impacts are evaluated with respect to their deviations from impacts associated with Alternative A.

Interregional Public Health Program Activities--

As discussed in Chapter II, certain AID-supported activities for public health programs are interregional in nature. These activities typically address vector control problems common to two or more of the several geographical regions. The development of resistance to commonly used insecticides, such as DDT and malathion, has prompted research to develop and test substitute chemicals as well as alternative pest control methods. Where such programs are proposed that involve specific chemicals (e.g., in the program for Indonesia), this report reviews anticipated impacts in the appropriate regional discussion. Interregional programs that involve research on nonchemical control methods for vector-borne diseases are considered not to affect directly either the public health or the environment. However, secondary impacts resulting from the application of research findings can be anticipated in some cases. Since the focus of proposed research activities is on more effective methods of controlling vector-borne disease, the potential impacts from a public health standpoint will most likely be positive. Likewise, from a socioeconomic standpoint, research activities initially provide an economic

advantage through employment, salaries, etc., and have the long-term potential for increased social well-being through an upgrading of the productivity of the people presently afflicted by disease. Environmentally, research aimed at upgrading understanding of pesticide applications and implications should serve to diminish negative impacts of future pesticide usage. However, research aimed at developing alternatives to pesticides for vector control purposes pose both negative and positive potential environmental impacts and will require individual evaluation prior to implementation.

Impacts of Alternative A--

Discussed in the following sections are the impacts which may result from programs implemented under Alternative A. The potential human health, environmental, and socioeconomic impacts in Latin America, Africa, and Asia are addressed first. Then the extraterritorial global and U.S. impacts, short-term benefits versus long-term effects, unavoidable adverse effects, and irreversible and irretrievable commitment of resources are discussed for the pesticide activities conducted in all AID public health programs proposed under Alternative A.

Latin American programs--

Human health--The program proposed by the Government of Haiti to control malaria calls for the use of DDT to the extent that it remains effective, supplemented by malathion. All insecticide applications will involve spraying the interiors of homes. To augment these field control measures aimed at vector control, a significant program of chemoprophylaxis and treatment is proposed to reduce the reservoir of infection. In addition, training of additional public health personnel and field crews and on-site technical assistance is proposed.

The malaria control program, as proposed by the Government of Haiti, embraces the concept of an integrated approach to controlling a pest and stopping a disease. Pesticides will be used to control the vector, drugs to control the disease, and epidemiological surveillance to monitor progress and to redirect efforts as needed; training and technical assistance will be provided to optimize all facets of the program. Viewed from the overall standpoint of public health, AID participation in the Haitian malaria control program constitutes a benefit to Haiti.

The program is designed to reduce the high rate of sickness and mortality caused by malaria. Rural areas will be the prime target of the pesticide activities. The rural population of 4 million people (80% of Haiti's total population) suffers severe health problems. Malaria and other endemic diseases contribute to a gross death rate of 36 per 1,000, and

infant mortality of 147 per 1,000. Malaria cases now reported are 5,500 per million (27,500 total) annually. The goal of the program is to reduce malaria cases to 500 per million by the end of FY 1981 (2).

Impacts on human health from the proposed program would be both positive and negative. The potential direct positive impacts would be the reduction of malaria-caused deaths and/or sicknesses by 25,000/year, a reduction of the infant mortality rate, a slight increase in the low life expectancy of 45 years, and the freeing of doctors and medical facilities for the treatment of other ailments (which is critical in Haiti because there are 11,550 people per doctor). Potential negative impacts would be a slight increase in the population growth rate of 2.0%, exposure of people to DDT residues in homes, exposure of spray applicators to DDT and malathion, and the potential long-term development of resistance to DDT by malaria vectors (2).

Further, proposed training and technical assistance activities for Latin America will have additional positive impacts for Haiti. In Haiti, activities will include: (a) training of insecticide spray applicators; (b) training of participants in water management to reduce malaria by reducing breeding areas; (c) providing malariology programs for trainees; and (d) conducting concentrated epidemiology and entomology studies.

Activities for Bolivia are focused mainly on the development of data for establishing basic approach plans for malaria control. These training and technical assistance activities constitute an integral part of overall pest management activities, and not only promote wise selection and use of insecticides, but also strengthen the concept of an integrated approach to the control of vector-borne diseases. The greatest positive impact of such activities will be to reduce unnecessary human exposure to insecticides through proper education and skill development of spray applicators.

Environment--DDT usage against malaria vectors in Haiti was 80 MT in 1976 and is anticipated to be 40 to 60 MT in 1977 (3). During spraying of interior walls and ceilings, an estimated 6% of the spray is deposited on the floor and 2% on the soil outside the house (4). Estimated potential direct release of DDT to the environment during spraying operations would therefore be from 2 to 8% of the total applied amount, or an upper limit of perhaps 6 MT in 1976 and 3 to 5 MT in 1977. Haiti has a land area of 11,000 sq miles (28,499 sq km). Assuming uniform environmental contamination, average DDT deposition would be 0.03 to 0.05 g/ha. However, actual DDT levels are known to range from nil to 10 g/ha. Thus DDT levels in the environment would be 1/2000 to 1/200 the average agricultural application rate of 2 kg/ha found in many parts of the world (4). DDT released to the environment is normally limited to areas immediately surrounding the treated

homes, and terrestrial wildlife would therefore be exposed only in those areas.

Assessment of environmental hazards of DDT in public health programs must consider use patterns and transport of residues from the application sites. As previously noted, an estimated 2% of the DDT applied as a domicile spray is deposited on the soil near the house. The only wildlife directly exposed would be domestic pests and soil organisms to which DDT is only slightly toxic. Exposure of other wildlife would therefore occur only if residues were transported from the deposit site. Volatilization and leaching losses of DDT from soil are low; e.g., movement in loam soil is less than 10 cm/year in soil receiving 150 cm annual rainfall. DDT in runoff water is normally not significant due to its low solubility, but adherence to soil particles will result in some loss due to soil erosion (see Appendix B).

Wildlife may also be exposed to DDT from accidental spills that occur during handling and transportation. The frequency of such exposures is not known, making estimations of effects on wildlife impossible. However, the amounts of DDT inadvertently introduced into the environment in this manner are believed to be insignificant in comparison to the amounts used in malaria control operations.

Because of the initially low environmental contamination and use pattern for public health purposes, DDT used in malaria control programs does not appear to pose significant hazards to wildlife in general (5), to jeopardize the endangered species of Haiti, or to add significantly to DDT residues in the air, water, and soil.

Socioeconomics--Haiti is one of the 25 least developed countries in the world. The average per capita GNP was $120 in 1973. However, the per capita GNP in rural areas, where 80% of the people live, was under $70. Most of the population is engaged in subsistence agriculture on arable land which averages only half an acre per person. Rural areas are relatively isolated with limited agricultural marketing facilities and transportation. The population is 90% illiterate, and only 20% of the rural children enter first grade (2).

The currently identified AID malaria control program in Haiti will have social and economic impacts on the people living in the rural areas where these activities are conducted. The most important economic and social benefits will be derived primarily from the control of malaria and will depend upon the extent to which malaria control is achieved. Substantial benefits will occur in the form of lives saved, human resources saved through the prevention of illness, reduced medical costs, and increased human productivity from a sense of well-being when effective results are achieved.

Disbenefits may accrue from the use of DDT since malaria vectors in Haiti are becoming resistant to this pesticide. In the long term, the costs of malaria control will increase as higher levels of DDT are required, or more expensive substitute pesticides such as malathion or propoxur are needed. Other potential economic disbenefits in the form of contamination of the environment by DDT, leading to the destruction of economically important and beneficial wildlife, birds, fish, and insects, are possible, but these effects should be minimal under the proposed program of spraying the interiors of homes.

African programs--AID public health programs in Africa which involve pesticide actvities are malaria control programs in Zaire and Ethiopia, an onchocerciasis control program in seven countries (Benin, Ghana, Ivory Coast, Mali, Niger, Togo, and Upper Volta), and a tsetse fly control program in Tanzania. The potential impacts of these programs on human health, the environment, and socioeconomics are discussed below.

Human health--

Malaria control programs--Pesticides proposed for use in Zaire for malaria control include DDT, malathion, and the larvicide Abate®. For Ethiopia, the major insecticide to be used is DDT; malathion is also needed to overcome resistance problems. Residual indoor spraying will be the only use for DDT and malathion. Abate® will be applied to mosquito breeding areas.

The program in Zaire is designed to establish model malaria control programs to reduce the sickness and mortality caused by malaria. Kinshasa and one or more nearby rural areas, where a total of 2.5 million people (about 12% of Zaire's population) live, will be the prime target of the program. Both spray equipment and pesticides will be furnished to treat homes and mosquito breeding areas (6).

The program in Ethiopia is designed to reduce the incidence level of malaria to 5% or below in 90 to 95% of the covered localities in the malaria eradication program (6).

Impacts on human health from these proposed programs are difficult to assess since no specific data are available regarding the quantities of pesticides to be used, the number of people who will be affected, or the incidence of malaria in the program regions. In general, however, the direct positive impacts in Zaire and Ethiopia would be a reduction in the number of deaths and sicknesses caused by malaria, a reduction in the infant and child mortality and morbidity rates, a slight increase in the low life expectancy (44 years in Zaire and 38 years in

Ethiopia), and the freeing of doctors and medical services for the treatment of other ailments (which is critical in Zaire and Ethiopia since there are 26,000 and 76,000 people per doctor, respectively). Direct negative impacts would be a potential slight increase in the high population growth rates of 2.4% in Zaire and 2.6% in Ethiopia; exposure of people to DDT and malathion residues in homes and to Abate® residues in water; exposure of spray applicators to the three pesticides; and the potential development of resistance to the three pesticides by malaria vectors.

The negative human health impacts of DDT and malathion usage would be of a different nature. DDT poses the potential risk of chronic exposure to a possible carcinogen while malathion poses the risk of poisoning the applicators and inhabitants directly if this pesticide is improperly used. To date, however, no poisoning incidents involving DDT or malathion insecticides are known for Zaire or Ethiopia.

Abate®, an organophosphate, has been shown in human studies to be low in toxicity when taken orally and applied dermally. Normal concentration of Abate® in water under field conditions is about 0.5 ppm. Assuming that the average adult consumes 2 liters of water per day, the maximum daily quantity of Abate® imbibed would be about 1 mg. This compares with a dosage of 256 mg/man/day fed to human volunteers for 5 days and 64 mg/man/day for 4 weeks without clinical symptoms or side effects and without detectable effects on red blood cell or plasma cholinesterase (7). Through the dermal route, Abate® is even less toxic to humans than orally. Furthermore, as an organophosphate chemical, Abate® has a fairly short half-life, is not stored in the body, and produces no known chronic or residue effect. (See Appendix B for more detailed descriptions of Abate®.)

The proposed use of Abate® for malaria control purposes in Zaire and Ethiopia offers little potential for harm to human health. The use of DDT and malathion involves risks which must be weighed against the substantial benefits of malaria control. Their use in the proposed programs as important elements in an integrated program for malaria control holds great potential for reducing human suffering and death caused by this disease in this area of the world.

Onchocerciasis control program--The program is designed to reduce the incidence of onchocerciasis (river blindness) in the Volta River Basin. The major pesticide to be employed throughout the program is Abate®. A panel has been established to monitor the ecological effects of Abate® during this program. This larvicide will be applied weekly by aircraft to fly breeding areas along rivers. In addition, extensive on-site training and technical assistance will be provided by WHO and AID. An advisory team consisting of flight crews, epidemiologists, and other necessary personnel

will actively participate in the design, training, execution, and monitoring of the entire program.

The major impact of this program would be the reduction of the occurrence of onchocerciasis, a parasitic disease that afflicts an estimated 1 million people. The suffering and loss of eyesight take a devastating toll, and the potential benefits of the program are substantial. The most important negative human health impact would be the potential human exposure through direct contact with spray drift from aerial spraying of Abate® and with pesticide residues in river water.

As previously discussed, Abate® has a low toxicity to humans and represents a minimal human risk. Whether ingested or absorbed dermally, this pesticide is relatively safe to humans. Hence, the potential risk is very much lower than the potential benefits.

Tsetse fly control program--A sterile insect release program will be conducted in Tanzania to control the tsetse fly, which transmits trypanosomiasis, or African sleeping sickness, to man (and to animals). The sterile insect release control method has been tested on the tsetse fly with small-scale trials in a small isolated area of Rhodesia and was found to be highly effective. The program in Tanzania is scheduled for more widespread testing under the normal conditions of large land areas.

Trypanosomiasis is a significant contributor to human death and suffering and is quite difficult to control. Incidence of infection in some endemic regions is as high as 30% of the population. If the proposed program is effective in controlling the tsetse fly, a major positive impact on human health would result in Tanzania with the reduction of the incidence of this disease. In view of the lack of negative results of other sterile insect release programs on public health, it can only be assumed that the potential benefits will far exceed the human risks.

Environment--Data are very limited on pesticide use patterns and quantities required in African public health programs. Control of malaria in Zaire and Ethiopia, and onchocerciasis in the Volta River Basin anticipates use of DDT, malathion, and Abate®.

Quantitites of DDT, malathion, and Abate® to be procured for control of malaria vectors in Zaire have not been determined. Applications of Abate® and malathion were originally scheduled for FY 1976 but amounts were not specified. No assessment of the magnitude of direct impacts on water quality, soil quality, or air quality associated with the Zaire malaria program can be made. However, little contamination of the environment should result from spraying the interior walls of homes with DDT and

malathion, and the contamination of the environment with Abate® applied to mosquito breeding areas poses little threat. Field tests in the United States indicate spray applications of Abate® to streams and ponds for mosquito control did not result in persistent residues, and Abate® residues did not accumulate in the bottom sediments (8). Application of Abate® during Zaire's malaria program should not present significant environmental hazards because of its lack of persistence and buildup under exaggerated treatment rates.

The persistence, toxicity, and bioaccumulation potential of the compounds must be considered with respect to cumulative and indirect impacts on wildlife. DDT degrades very slowly and does build up in some food chains (see Appendix B). Use therefore involves potential effects on wildlife through bioconcentration of DDT residues. However, global DDT use for malaria vector control is considerably less (15 to 20% of total production) than worldwide agricultural use (9). Losses of DDT in tropical Africa during malaria control program applications have been estimated at 10 g/ha in areas with 100 inhabitants/sq km, contrasted to 2 kg/ha when DDT is applied for agricultural purposes (4). Application of DDT in Zaire's public health programs should not result in significant adverse impacts on wildlife at the generally low loss levels.

Malathion does not bioaccumulate and degrades rapidly, i.e., 50 to 90% degradation in soil within 24 hr of application under U.S. field conditions (10) and can be expected to be even more rapidly degraded in tropical and subtropical areas (11). Although it is highly toxic to fish and moderately toxic to birds, malathion sprayed on interior walls of homes has little chance of contacting either birds or fish unless allowed to drift during application. Migration from the site of application is minimal due to its high degradation rate.

Abate® is relatively nontoxic to all forms of wildlife and fish. However, it is toxic to some water organisms that are a source of food to fish, and has the potential for upsetting the ecological balance in waterways.

Data are more specific on quantities of DDT required in the Ethiopian malaria program. Planned usage is 2,000 MT DDT for interior domicile spraying in 1976 and 1977 (1,000 MT/year). Estimated normal deposits of 2% spray on soil and 6% on floors would result in losses of 80 MT DDT to the environment annually. Such losses would be confined to malarious regions. Loss in treatment areas where there are 100 inhabitants/sq km has been estimated to be 10 g/ha (4). Losses of this magnitude do not pose a significant threat to wildlife or the environment.

Small unspecified amounts of malathion may be applied in Ethiopia where malaria vectors exhibit DDT resistance. Impacts associated with malathion usage have been discussed above.

Abate® is the proposed larvicide for decreasing incidence of onchocerciasis. The proposed AID program specifies that Abate® will be aerially applied weekly to active fly breeding areas. Amounts of Abate® to be procured are not yet known. As discussed previously, the use of Abate® should not result in direct negative impacts on wildlife or the environment, with the exception of possibly upsetting the ecological balance between fish and their source of food. However, areas freed of onchocerciasis will be resettled and developed, potentially disrupting or destroying habitats now occupied by wildlife species. Survival potential of threatened species inhabiting Ethiopia may be minimized by the encroachment of man.

Control of the tsetse fly by release of sterilized male flies does not involve introducing a nonindigenous parasite or predator organism, and therefore, should not result in ecosystem disruption from the competition of a new species. This approach would reduce pesticide usage and would reduce contamination of wildlife and the environment. Reduction of tsetse fly populations should have a direct positive effect on wildlife, since the tsetse fly appears to hold no direct beneficial role in the ecosystem and adversely affects many game animals by spreading animal trypanosomiasis (12). Although tsetse fly control may be initially beneficial to wildlife, encroachment of man and livestock into trypanosomiasis-freed regions holds the potential of destroying wildlife habitats and displacing indigenous species.

Socioeconomics--The currently identified AID public health programs in Africa will have social and economic impacts on the people living in the geographical areas where these activities are conducted, and others as well. The most important economic and social benefits will be derived primarily from the control of malaria, onchocerciasis, and trypanosomiasis, and will depend upon the extent to which control of these diseases is achieved. Public health socioeconomic benefits and disbenefits will not differ a great deal from those discussed for Haiti under the Latin American programs except that the number of people affected in the African programs is much larger.

A major impact of the African programs that will occur in many cases of successful control of diseases to humans (and domestic livestock) is that vast areas of both arable and pasture lands may be made available for development. The onchocerciasis control program is an excellent example of this type of impact. AID believes that if this disease can be controlled in the Volta River Basin, the economic losses due to retreat of the population from the heavily infested fertile river valleys can be reversed by resettlement and development of the river areas. Should this occur, about 70,000 sq km of land that is both fertile and productive would be available for agricultural purposes. The economic benefits of enlarging a region's agricultural foundation are obvious. Moreover, social benefits would also be realized from the increased land area made available for human habitation.

In comparison to Latin American programs, the positive impacts of the African programs should be greater since the potential reduction of disease in humans involves over a million afflicted people, and involves freeing vast areas of presently uninhabitable land for habitation and agricultural use. The socioeconomic costs of environmental contamination should be proportionately less in Africa since two programs involve the use of the relatively nontoxic Abate® and a sterile insect release control method. In summary, the public health programs in Africa, if effective, should produce substantial agricultural, economic, and social benefits.

Asian programs--AID public health programs in Asia which involve pesticide activities are malaria control programs in Indonesia, Nepal, Pakistan, and Sri Lanka. The potential impacts of these programs on human health, the environment and socioeconomics are discussed below.

Human health--

Indonesia--The proposed malaria control program in this country represents an integrated approach including pesticides, training and technical assistance, epidemiological surveillance, medical treatment, and research. The predominant pesticide to be employed will be DDT used for residual spraying. Malathion will be used at present only in small quantities, 1 MT total, for research purposes under controlled conditions.

This program will potentially affect the lives of more than 100 million people in Indonesia. The Indonesian Department of Health estimates that 94% of the population are at risk from malaria. The most recent records (1972) show 128,000 malaria cases in the Central Islands (Java, Bali, and Madura) and 155,000 cases in the Outer Islands. In view of inadequate case detection procedures, and actual number of malaria cases in the Central Islands may exceed 1 million and the number in the Outer Islands over 6 million (13).

The major impact of the program will be the reduction in the staggering total of malaria cases. In the Central Islands, it is expected that a control level of about one case per 1,000 population can be obtained, as compared to a level of over 13 reported cases per 1,000, and escalating in 1973. Should this level of control be achieved, the annual number of malaria cases in the Central Islands would be reduced by at least 100,000, and possibly as many as 1 million (14).

Other direct positive impacts in Indonesia would be a reduction in the 50% mortality rate among pre-school children, an increase in the 48-year life expectancy, and relief of the extreme burden on doctors and medical services caused by the current large number of malaria cases (which is critical in Indonesia because there are 25,800 people per doctor). Potential negative impacts would be an increase in the high population growth rate

of 2.1%, exposure of people to DDT residues in treated homes, and potential development of vector resistance to DDT (15).

Nepal--As demonstrated in other sections of this report, there is a significant and growing need for malaria control. The principal pesticide to be employed in the proposed program is DDT. However, in view of the resistance to DDT in portions of the country, it is thought that a DDT substitute, malathion being the best available second choice, may be required.

The major impact of the program will be a reduction in the number of deaths and illnesses attributable to malaria. The total number of malaria illnesses is projected to increase from 25,000 in 1975 to 400,000 cases per year by 1980 in the absence of a control program. With the implementation of a control program involving pesticides, training and technical assistance, epidemiological surveillance, and medical treatment, the total number of malaria illnesses is anticipated to decline to 3,000 cases per year by 1980. Over the proposed 5-year program, a total of 1 million cases of malaria are expected to be prevented. While the figures are a best estimate only, they do indicate a tremendous potential public health benefit resulting from the proposed program.

Other impacts, both positive and negative, would be similar to those in Indonesia.

Pakistan--The renewed malaria control program in this country has been designed with past shortcomings in mind. Experienced manpower and government resources will be combined with WHO and AID dollars, commodities, and field personnel in a sustained effort to control the disease. The program expectations are to reduce malaria cases over the 5-year period from the 1974 estimate of 10 million cases, to 35,000 to 40,000 cases by 1979. Assuming a conservative death rate of 1% of all cases, this would save approximately 100,000 lives annually.

Sri Lanka--As pointed out in Chapter II, page 124, this country is experiencing a rapidly escalating malaria infection rate. While no specific data are available indicating the extent of the expected positive effect of the proposed control program, the need for malaria control is certainly appreciable. The only AID-furnished pesticide to be employed in this program is malathion because of resistance in the vector population to DDT. To ensure safety as well as program effectiveness, AID presently plans to furnish on-site technical assistance for training of professionals in parasitology, epidemiology, and entomology.

With regard to human poisoning, persistence, and resistance problems associated with the above proposed public health pesticide activities, BHC is the only compound unique to this area and not previously discussed. A member of the chlorinated hydrocarbon family, this insecticide, with its five isomers, is relatively stable in man's environment. Although it is absorbed through all routes of exposure, BHC is most toxic when administered orally. Reported poisoning incidents involving this pesticide include suicides, a high frequency of dermatitis among workers handling the powder, and a village epidemic in 1951 stemming from improper use of BHC on walls, floors, and bedding of dwellings. In addition to its acute toxicity potential, BHC has been demonstrated to be carcinogenic in mice. Overall, use of this pesticide, whether for public health or any other purposes, poses a relatively high risk. Its use for vector control purposes is usually considered only in situations where resistance problems dictate. (See Appendix B for a more detailed description of BHC.)

Environment--AID funds extensive malaria control programs in Asia. All currently identified programs plan or propose residual spraying of interior walls of homes. Malathion, DDT, fenitrothion, and BHC will be the residual sprays applied.

AID is supplying grants for FY's 1976 to 1979 for malaria control in Nepal. Malaria is present in 50% of Nepal's land area, occurring mainly in the fertile valleys and plains (16). Agricultural development of these regions is greatly hindered by malaria incidence. Application of DDT is planned only in malarious regions. Funds allotted for DDT procurement are $1.9 million in 1976, $2.1 million in 1977, and $2.4 million in 1978. Based on a total procurement cost to AID of $0.50/lb DDT, dollar value would equate to approximately 1,700 MT in 1976, 1,900 MT in 1977, and 2,200 MT in 1978. Assuming 2% spray deposit on the soil and 6% deposit on the floor, environmental losses would be 140 MT in 1976, 150 MT in 1977, and 170 MT in 1978. Nepal's land area is 14.1 million hectares (54,400 sq miles); the area of malarious regions would be 50% or 7.0 million hectares (27,000 sq miles). Average annual loss of DDT would therefore be 0.6 to 0.7 g/ha. Actual losses in affected areas would probably range from 0 to 10 g/ha (4). Losses of this magnitude have a minimal effect on wildlife. DDT is slightly toxic to soil organisms, the only fauna potentially directly affected by public health home spraying.

DDT, in addition to malathion, will be applied for malaria control in Pakistan and Indonesia. Usage of BHC is planned in Pakistan. Table 52 presents total insecticide quantities to be applied and estimated potential loss to environment during application, based on reported values of 2% spray deposited on the soil and 6% on floors (4).

Table 52: Estimated Potential Environmental Contamination from Malaria Control Programs in Pakistan and Indonesia[a/]

Compound and Year	Total Planned Usage (MT)	Estimated Potential Loss (MT)[a/]
	Pakistan	
DDT		
1976	1,417	113
1977	900	72
1978	?	-
BHC		
1976	3,300	264
1977	2,000	160
1978	?	-
Malathion		
1976	7,250	N/A
1977	9,000	N/A
1978	800	N/A
	Indonesia	
DDT		
1976	3,750	300
1977	3,750	300
1978	3,000	240
1979	3,000	240
Malathion[b/]		
1976	< 1	N/A
1977	10	N/A
1978	?	-
1979	?	-

a/ Based on estimated environmental losses of 8% of DDT spray during application (2% on soil, 6% on domicile floors) (4).

b/ Malathion will be applied on Java where resistance problems exist (14).

Significant amounts of malathion may be procured for an anticipated antimalaria program in Sri Lanka. The AID-proposed program designates that $12 million be allotted for malathion purchase (15). Based on a total procurement cost to AID of $1.00/lb malathion, the proposed dollar amount would equate to 2,200 MT. Malathion degrades rapidly under normal environmental conditions and does not appear to pose a significant threat to wildlife or the environment when applied to the interiors of dwellings.

A more complete discussion of the impacts of DDT and malathion on the environment was presented in the Latin American and African environment sections on pages 241 and 245, respectively. Similar impacts may be expected to occur in Asian regions.

The environmental impacts of BHC used in Pakistan would be similar to those of DDT. BHC is moderately toxic to wild mammals; highly toxic to fish and lower aquatic organisms; slightly toxic to birds; slightly to relatively nontoxic to soil organisms; and very persistent. The magnitudes of the potential impacts associated with BHC, however, would be greater because of the greater quantities involved (see Table 52).

Socioeconomics--The currently identified AID public health programs in Asia include the financing of DDT, BHC, and malathion for malaria control, and technical assistance and training of personnel in malaria control programs. Each area of activity will have social and economic impacts on the people living in the geographical areas where these activities are conducted, and others as well.

The socioeconomic impats of AID-supported public health programs in Asia are basically similar to those in other regions of the world. Since the primary thrust of such programs is the reduction of human disease and its ramifications, the primary impact of successful programs would be reflected in longer life expectancy, lower infant mortality, lower morbidity among the general population, and a healthier, more productive labor force in general that could increase individual income levels, overall employment levels, and GNP.

Asian countries with severe malaria problems are generally little developed. The human health benefits of public health programs foster social and economic changes such as improved worker productivity which leads to increased food production. Food production would also be enhanced by clearing potentially productive lands of disease vectors which inhibit development. As food production levels increase, hunger and malnutrition decrease with concomitant rises in productivity and perhaps change toward industrialization. The ultimate socioeconomic impact would be for all these mutually enhancing beneficial effects to result in social and economic self-sufficiency for the country. However, small countries with limited resource bases and dense populations must continue to receive outside assistance to maintain progress toward higher levels of economic development.

The subject of socioeconomic impact must be reviewed in its totality. It consists of a web of effects which causes other effects. In general, the socioeconomic impacts of public health programs are beneficial to recipient countries and materially assist in their struggles to achieve a better quality of life.

Extraterritorial global and United States impacts--AID pest management programs for public health in LDC's have potential impacts on the extraterritorial global environment and the United States. Areas of impact include the global atmosphere, global waters, migratory wildlife, and health, environment, and socioeconomic status of the United States. The most significant potential impacts in these areas attributable to AID activities would be:

Area	Impact
Global atmosphere	Pesticide residues
Global waters	Pesticide residues
Migratory wildlife	Exposure to pesticides; habitat modification
U.S. health	Occupational exposure to pesticides; exposure to pesticide residues in air, water, and imported foodstuffs
U.S. environment	Environmental pollution by U.S. pesticide manufacturers; global transport of pesticides to United States
U.S. socioeconomics	Pesticide industry; food importing industry

Pesticide residues in the global atmosphere and waters could result from spray drift, volatilization, runoff, leaching, and direct application to water. Only DDT has a significant pollution potential among the four pesticides AID anticipates financing for public health programs. Malathion and Abate® degrade rapidly in air and water. BHC will be used in relatively small amounts.

DDT is very persistent, and is known to be present in the air and water throughout the world. AID responsibility for global DDT residues must be assessed in terms of its contribution to global levels; this contribution would be insignificant for two reasons. First, DDT is applied to the interior walls of homes in AID public health programs, and this method of application introduces only a small portion of the total amount of DDT used into the environment. Second, the total annual worldwide usage of DDT is estimated to be about 200,000 MT, and only about 42,000 to 45,000 MT are used for public health purposes--the remainder for agriculture (9,17). AID's DDT requirements are a minor proportion of total worldwide usage.

Exposure of migratory wildlife to AID-financed pesticides will have an insignificant impact when considering the method of pesticide application used in public health programs and the exposure the wildlife receives from worldwide agricultural applications of pesticides. Habitat modification, however, may result from programs, such as the onchocerciasis control program in the Volta River Basin, that free uninhabitable areas from disease, and result in resettlement or development of the area by humans. Such modifications could disrupt the life patterns of affected wildlife species.

Health effects on people in the United States would be limited to occupational exposure of workers in the segment of the pesticide industry which manufactures, formulates, stores, and transports DDT, BHC, malathion, and Abate®; exposure of the general population to pesticide residues on foodstuffs imported from the countries which receive AID-financed pesticides for public health; and exposure of the general population to pesticide residues in air and water from global transport of the air and water from LDC's and contaminated by U.S. manufacturers and formulators of the four pesticides. AID's contribution to occupational exposure of workers would only be the amount of pesticides AID purchases as a percent of the total amount of pesticides produced and formulated, multiplied by the number of workers who are exposed.

Data are not available on the total amounts of foodstuffs imported into the United States from LDC's, but the amount of pesticide residues on food attributable to AID public health programs is probably insignificant since the pesticides do not reach agricultural crops except in extremely small quantities, if at all. AID's contribution to the exposure of the general U.S. population to air and water polluted with pesticides used globally is an extremely small proportionate share of the world contribution. The pesticide pollution of U.S. air and water by AID-financed pesticides manufactured and formulated in the United States would be even less than their proportionate share of the total produced and formulated, since all four pesticides are used in this country, and this usage makes additional contributions to the pollution of U.S. air and water.

Social conditions in the United States are virtually unaffected by AID pesticide activities in LDC's. Economically, the employment, sales, and profits of that segment of the U.S. pesticide industry which supplies pesticides for AID public health programs are small in relationship to their total employment, sales, and profits, and AID finances used for the purchase of pesticides contribute little to the economy of the United States.

Short-term benefits versus long-term effects--There are two primary considerations regarding short-term health benefits versus long-term effects: (a) control of disease versus development of resistance, and (b) disease control versus long-term exposure to pesticides in dwellings and the environment. The trade-off can be partially circumvented through application of integrated pest management techniques and the use of less persistent pesticides, when effective.

Short-term benefits to wildlife are closely linked to long-term effects. Control of the tsetse fly will benefit wildlife which can be infected by trypanosomiasis. However, freeing regions of trypanosomiasis, or any other disease that prevents settlement by man, may result in adverse impacts on wildlife resulting from the encroachment of man. The encroachment of man may be one of the greatest threats to certain wildlife (5).

Trypanosomiasis and malaria have prevented the settlement and agricultural development of many regions important as wildlife habitats. Reduction of animal trypanosomiasis will allow introduction of livestock, possibly resulting in overgrazing, competition with wildlife, modification of habitat, and destruction of ground cover. Settlement of regions freed from malaria and trypanosomiasis by man may result in clearing land (modifying the habitat), agricultural development, and the associated pollution (pesticide residues, erosion, etc.), all adversely affecting regional wildlife. The magnitude of such impacts will depend largely on the degree and rapidity of development of disease-free regions.

Unavoidable adverse effects--The unavoidable adverse effects of Alternative A on human health are the development of vector resistance to pesticides, and exposure of people to pesticides. The loss of a slight amount of pesticide to the environment and its adverse effect on sensitive life forms is virtually unavoidable.

Irreversible and irretrievable commitment of resources--A certain degree of resource commitment (e.g., chemicals, energy, petroleum, manpower, etc.) is required for the manufacture, transport, distribution, and application of pesticides. These commitments would be irretrievable. The altering of a wildlife habitat potentially has significant effects (13) and may be irreversible. Should any species of living organism be rendered extinct directly or indirectly by AID-supported public health programs, the loss would be irreversible.

Impacts of Alternative B--

For Alternative B, pesticide activity for public health programs in any region would also be subjected to a "risk-benefit" evaluation as set forth in Chapter III, page 214. This evaluation will consider the potential benefits conferred by the use of the proposed pesticide, the availability of efficacious substitutes (pesticides or pest management activities), costs of control, and the extent of human and environmental risks involved. The training and technical assistance programs and other pesticide management activities would remain unaltered.

The overall impacts of Alternative B should be more beneficial to regions that receive AID-financed pesticides than the impacts of Alternative A for the simple reason that the analyses will be aimed at optimizing the benefits of pesticide activity in these regions while minimizing the disbenefits. At the minimum AID would proceed to finance pesticides for public health in the same manner as outlined in Alternative A, should the analyses show that no increase in benefits nor decrease in disbenefits would be forthcoming from an alternate course of action. In this case the pesticides financed under Alternative B would be the same as those for Alternative A, and the impacts of the two alternatives would be identical.

In the event that the analyses showed that an alternate course of action, such as the substitution of malathion or propoxur for DDT in certain malaria control programs being more beneficial to the recipient regions, then such action would be taken to the benefit of the recipient of the pesticides. This would involve trade-offs between health, social, environmental, and economic considerations, but the overall effect would be beneficial.

The impacts Alternative B would have, in relationship to the impacts of Alternative A discussed previously, on each of the seven organizational areas are discussed below. Without complete quantitative and qualitative data for all currently identified AID pesticide procurements for public health programs, it is impossible to forecast the change in health, environmental, and socioeconomic benefits that this alternative would provide. However, it is conclusive that this alternative is preferred to Alternative A with respect to impact considerations in that the addition of an analysis to the current pesticide procurement procedures will lead AID closer to optimizing the benefits that pesticide activities provide recipient countries.

Human health--In view of the paramount importance of promoting and preserving the public health and the minimal adverse impacts associated with use of inspecticides as previously described, it is assumed that the restrictive measures imposed by Alternative B will not alter the proposed use status of insecticides for public health purposes where a clear need can be established. The health impacts of Alternative B will, therefore, be similar to those of Alternative A.

Environment--AID pesticide activities under Alternative B would not drastically alter impacts on the environment attributable to AID public health programs. The planned pesticide usages discussed under Alternative A would not be altered other than to increase the potential substitution of malathion and propoxur for DDT. The effects on wildlife of DDT, malathion, BHC, Abate®, and any other pesticides used under Alternative B would be analogous to the impacts associated with Alternative A.

Socioeconomics--One element of the analysis called for in Alternative B is the potential for curtailing a proposed health program due to economic constraints. The governments of the less developed countries typically have limited funds to control diseases and promote good health and well-being among their people. Within this context, any action which tends to raise these costs can seriously jeopardize the success of a program. This is particularly true in vector-borne disease control where success is dependent upon vigorous and continuous actions. To gain a better appreciation of the economics involved, a discussion of available insecticides for malaria control follows.

At present, only three insecticides outside of the chlorinated hydrocarbon group are effective available substitutes for DDT in residual spraying: malathion (an organophosphate); propoxur (a carbamate), and fenitrothion. Table 53 presents the relative costs of using DDT, malathion, and propoxur for malaria protection through residual spraying. (A more recent cost comparison is shown in Table 45, page 192.) As shown, DDT is the insecticide of choice for as long as it remains effective. Any action forcing a change to malathion or propoxur at a constant budget level would constrain the program by factors of over 3 and 8, respectively.

Extraterritorial global and United States impacts--Impacts on extraterritorial global areas and on the United States would closely parallel those for Alternative A. DDT usage for public health would be allowed under Alternative B after an analysis justifies procurement; the analysis may shift activity to some degree toward the less persistent compounds such as malathion or propoxur. Usage of less DDT would reduce the negative impacts attributable to it under Alternative A, but the net change in total effect would be negligible.

Short-term benefits versus long-term effects--Alternative B would result in similar long-term effects as Alternative A. Whether or not malathion is used more frequently than DDT, control of disease will allow the encroachment of man. The long-term effects of persistent residues may be reduced if DDT and BHC are not used as frequently.

Unavoidable adverse effects--The unavoidable effects of public health pesticide usage would be analogous to those discussed under Alternative A.

Irreversible and irretrievable commitments of resources--Resource commitments required by AID under Alternative B would be essentially the same as under Alternative A.

Impacts of Alternative C--

Operations of anticipated public health programs would not be altered from the activities discussed under Alternative A. AID would continue usage of DDT, malathion, BHC, and Abate®, and other pesticides for control of

Table 53: Estimated Cost/Million Population Protected by Residual Spraying
(During a 6-month transmission period, in U.S. $000)

Insecticide	Insecticide Costs				Operational Costs					Cost Ratio DDT-1
	MT	Water Dispersible Powder	Trans-portation	Total	Application Rounds Number	Application Rounds Cost	Safety Equipment	Total	Total	
DDT, 75% water dispersible powder	133[a/]	66.5	5.3	71.8	1	133	-	133	204.8	1
Malathion, 50% water dispersible powder	400[b/]	355	16	371	2	266	-	266	637	3.08
Propoxur, 50% water dispersible powder	400[b/]	1,360	16	1,376	2	266	120[c/]	386	1,762	8.5

Source: Reference 18.
a/ Sprayable surface estimated at 50 sq m/capita x 1 round.
b/ Sprayable surface estimated at 50 sq m/capita x 2 rounds.
c/ Based on experience in a small-scale spraying operation (12,000 population) in southern Iraq.

disease vectors under the guidelines of Alternative C. Therefore, human health, environmental, and socioeconomic impacts as well as extraterritorial global and United States impacts, short-term benefits versus long-term effects, unavoidable adverse effects, and impacts of irreversible and irretrievable commitments of resources which may result from implementation of Alternative C would be analogous to those which may result under Alternative A.

Impacts of Alternative D--

Human health--Under Alternative D, no AID-financed pesticides would be supplied to less developed countries for public health purposes. However, other AID-funded activities such as training and technical assistance, research, and other pest management activities would continue. As has been demonstrated in the preceding sections, there is a clear need for implementation of an integrated program for the control of vector-borne diseases in these less developed countries. Without the use of pesticides to control the vector population, the benefit of the other aspects of the proposed program will be greatly diminished and the incidence of malaria cases and deaths can be expected to continue to rise. While the negative public health impacts due to the use of AID-financed pesticides that occur under Alternative A would not be attributable to AID under this alternative pest management program, the cessation of the financing of pesticides by AID would result in adverse effects on human health in the less developed countries.

Environment--Adverse impacts on wildlife and the environment associated with AID-financed pesticides used for public health purposes would not occur under implementation of Alternative D, i.e., no AID-funded pesticide activities. However, the quantity of pesticides potentially lost to the environment and adverse impacts from public health programs under Alternatives A, B, and C are relatively small. Modification of habitat, displacement of wildlife species, and disruption of indigenous ecosystems resulting during settlement and agricultural development of disease-controlled regions would not occur since obstacles preventing resettlement (malaria, onchocerciasis, and trypanosomiasis) would still exist. Potential benefits to wildlife from disease control would not be realized.

Socioeconomics--Under this alternative, AID would not finance any pesticides for public health programs in Latin America, Asia, and Africa. This action would eliminate most of the socioeconomic impacts that would be attributable to AID-financed pesticides under currently identified programs in these areas. The effect of this action, however, has various implications for the future fate of the affected areas.

The potential socioeconomic implications of terminating all AID pesticide activities in public health programs in Latin America, Asia, and Africa are difficult to assess without quantitative data regarding the extent of AID's present and future involvement in these regions relative to the total regional pesticide usage for public health, and without knowledge of what other international organizations, regions, or the countries would do to counterbalance the effect of cessation of AID pesticide inputs.

Extraterritorial global and United States impacts--The potential global health impact of zero pesticide usage for public health purposes attributable to AID pest management programs under this alternative would be nil. However, potential results of AID's lack of activity include the exposure of countries where such health programs has been undertaken to uncontrolled expansion of the various diseases.

Countries where malaria does not now occur as a major problem likely would also suffer effects of major malaria epidemics.

Alternative D would have no adverse effects on the extraterritorial global environment, migratory wildlife forms, or the United States because AID would not procure or donate any pesticides.

Short-term benefits versus long-term effects--The short-term benefits seen from stopping the use of pesticides would be the corresponding decrease in the attendant poisoning potential to humans and the environment as well as potential reduction in the immediate resistance problem. Further, the world load of persistent pesticide residues (e.g., DDT) and their effect on world biota would not be increased by AID pesticide activities. The obvious potential of the long-term effect of such an action would be dramatic increases in the incidence of disease and death.

Unavoidable adverse effects--The unavoidable effects of pesticide use on human health and on the environment would not occur under Alternative D. From a public health standpoint, this alternative would probably not reduce sickness and death from diseases which are controllable.

Irreversible and irretrievable commitments of resources--Resources (petroleum, chemicals, manpower, etc.) required for the manufacture, transport, and distribution of AID's public health pesticides program would not be required under Alternative D. A certain degree of resource commitment, e.g., manpower, materials, research supplies, etc., would continue to be required for the training, technical assistance, and research programs.

Impacts of Alternative E--

Human health--Under Alternative E, all AID-proposed activities in public health programs would be terminated. Accordingly, there would be no impacts to consider under this alternative for which AID would be accountable. However, from the standpoint of public health, this is the least desirable alternative in view of the potential of vector-transmitted diseases in these countries. If no other organization agrees to meet the demonstrated assistance needs of these less developed countries, a significant increase in cases and deaths from uncontrolled diseases can be expected. This condition would further undermine these countries' overall efforts to improve the health and well-being of their people.

Environmental--No environmental effects attributable to AID would result from implementation of Alternative E. However, some species of wildlife are also affected by the diseases infecting humans. Under the provisions of Alternative E, AID would no longer fund pesticides or any other pest management activities. AID-supported research on biological control methods for disease vectors would therefore be terminated. For example, work on tsetse fly control by the sterile male release technique would be terminated. Tsetse flies can also transmit a form of animal trypanosomiasis; their biting may adversely affect game animals (12). Implementation of Alternative E would therefore eliminate potential positive impacts on wildlife of tsetse fly control. An important means for influencing less developed countries to establish and enforce environmentally sound pest management programs would be lost. If the LDC's turn to other countries for pest management assistance, or conduct their own pest management programs, adverse environmental effects may actually increase because of improper use of other pesticides.

Socioeconomics--No socioeconomic impacts for which AID would be accountable would result from Alternative E. However, termination of technical assistance, training programs, and other pest management activities would eliminate the socioeconomic benefits that these activities would provide to recipient countries and regions.

Extraterritorial global and United States impacts--AID would conduct no pest management programs should Alternative E be implemented. Adverse impacts on human health and the environment therefore, could not be assigned in any part to AID activities. AID termination of training, technical assistance, and pest management research projects may have worldwide impacts should this role not be filled by another donor country. Many of the proposed research activities are aimed at developing biological controls and substitute chemicals for disease control, minimizing the need for pesticides. These programs would be terminated under Alternative E.

Other impacts--No short-term benefits, long-term effects, unavoidable adverse effects, or irreversible and irretrievable commitments of resources attributable to AID would result from this alternative.

Food Production and Preservation Programs

AID supports agricultural programs of potential benefit to all the recipient countries identified in Chapter II. The interregional programs include development of more resistant plant varieties; improved cultural and agronomic practices, and more effective methods for utilization of pesticides. Research activities of some programs are conducted within a defined geographical region, and those programs that involve pesticide activities are discussed within the appropriate regional discussion. Research on general pest problems can be beneficial to many areas and is conducted in interregional programs.

Interregional Food Production and Preservation Programs--

Research projects of interregional programs are generally initiated in the United States, but results are normally field tested in less developed countries. An example is a pest resistant soybean strain which was field tested in 20 countries. The interregional programs either do not involve pesticide usage or only very small amounts under strictly regulated conditions. Anticipated interregional research programs do not involve habitat modification techniques as a means of pest control.

The interregional research programs may impact both negatively and positively upon the environment and human health. AID supports research on developing insect and disease resistant varieties of grains (sorghum, millet, barley, oats, maize, and wheat) and legumes (soybeans, beans, and cowpeas). Successful development of resistant varieties will result in increased crop yield and a higher nutritional level in the recipient country. Resistant varieties should require less use of pesticides, thus reducing potential environmental contamination, residue problems, and human poisoning incidents. On the other hand, agricultural research in general may lead toward increased intensity of cultivation practices which could require higher pesticide inputs to complement other elements of such programs, e.g., double cropping, irrigation systems, chemical fertilizers, and increased plant densities.

AID funds research on increasing livestock production through control of disease vectors. Many regions of Africa are not used for livestock production because of the high incidence of animal trypanosomiasis, transmitted by the tsetse fly. Freeing an area of tsetse fly, thus allowing settlement by man and his livestock, may have both positive and negative impacts. Increased livestock production would result in higher protein availability and produce benefits to human health. However, the encroachment of humans and livestock will almost certainly affect wildlife in a negative way (5). Livestock may compete more effectively than wildlife for available food and range. Many wildlife habitats may be irreparably changed by conversion to cropland, pastureland, or residential areas, and wildlife species may be reduced in numbers or displaced.

The final interregional research area is for the development of methods of vertebrate pest control, e.g., rats, vampire bats, and noxious birds. Control methods include both chemical and physical pest management techniques. Noxious bird and other vertebrate pest attacks result in significant grain losses in Africa and Latin America (19,20); vampire bats negatively affect livestock production in Latin America (19,21,22); and vertebrate pests (e.g., rats) cause loss or contamination of stored foods (19,23). Minimizing crop loss to such pests increases the amount of food available to people in those countries, whose nutritional levels are usually low.

Training and technical assistance are also provided on an interregional basis. These programs identify and teach methods of effective and safe pesticide utilization as well as other concepts of integrated pest management in less developed countries. Efficient pesticide usage would reduce incidences of human poisoning and environmental contamination attributable to carelessness during pesticide application.

Based on currently identified activities (see Chapter II), pesticide activities are of secondary importance in the AID pest management program for food production and preservation. The main emphasis of currently identified food production and preservation programs is technical assistance and training for pest management techniques, as discussed in Chapter II. AID's approach to pesticide activities is to encourage responsible pesticide use in the less developed countries. Pesticides are used for demonstration purposes within some technical assistance and training programs; relatively small quantities are procured and applied. Because complete information on the quantities, chemical identities, and country of use has not been developed, specific assessment of impacts resulting from demonstration programs cannot be made.

The impacts of currently identified interregional programs which include pesticide activity, and all regional pest management programs are discussed in the following subsections. Impacts are subdivided into effects in the general categories of human health, the environment, socioeconomics, extraterritorial global and United States impacts; short-term benefits versus long-term effects; unavoidable adverse effects; and irretrievable and irreversible commitments of resources. Complete impact analyses, on the basis of available data, are presented for AID food production and preservation programs implemented under Alternative A. Impacts of Alternatives B through E are discussed on the basis of their deviation from the impacts associated with Alternative A.

Impacts of Alternative A--

Discussed in the following sections are the impacts which may result from programs implemented under Alternative A. The proposed food production and preservation programs involve the potential use of the 11 specific pesticides shown in Table 51 (page 233) which includes seven insecticides (two chlorinated hydrocarbons, four organophosphates, one carbamate) and four herbicides (two triazines, one urea, and one acetanilide). A review of the quantities of pesticides used in the past by AID (see Appendix B) and the pesticide activities included in the currently identified program suggest definite but limited use of chlorinated hydrocarbons, wide use of organophosphates, and use of selected carbamates and herbicides.

The potential human health, environmental, and socioeconomic impacts in LDC's which receive AID-financed pesticides in food production and preservation programs are discussed for these countries as a whole, since specific data on the crops, livestock, and stored food which will receive pesticide treatment are limited, as are data on the quantities of specific pesticides that would be financed by AID in these programs. Following the discussions in these three areas the extraterritorial global and United States impacts, short-term benefits versus long-term effects, unavoidable adverse effects, and irreversible and irretrievable commitment of resources are discussed for the pesticide activities conducted in all AID food production and preservation programs proposed under Alternative A.

Human health--Since the primary thrust of AID-supported food production and preservation programs is to increase the agricultural productivity in LDC's through increased food production, the primary beneficial impact of successful programs would be to raise the average nutritional level of the generally undernourished population of the LDC's. Other beneficial impacts of major importance anticipated as a result of increased nutrition would include a decrease in infant mortality rates, an increase in life expectancy, an increase in the overall quality of health, and an increase in the availability of critical medical services. These impacts would occur within the recipient LDC's.

Pesticide activities conducted in AID agricultural pest management programs would also have the potential for creating negative impacts within the LDC's. The potential major negative human health impacts would be increasing pesticide resistance in disease vectors and agricultural pests; exposing agricultural workers to pesticides; exposing segments of the general population to pesticides directly through residues in food; and exposing the general population to pesticide residues in the environment.

Pesticide resistance in disease vectors and agricultural pests--Two general observations have been made regarding the effects of using chlorinated hydrocarbon pesticides for food production and preservation activities on vectors of public health importance: (a) applications tend to diminish the susceptible adult population, and (b) use of pesticides for agricultural purposes correlates positively with the development of pest resistance to the

pesticide (24). While the first effect brings about an initial period of decreased disease transmission, the negative effects of the second effect may outweigh initial benefits.

One source of data substantiating this secondary effect comes from the National Academy of Science study team on problems of pest control (24). Investigation of the correlation between the extent of agricultural pest control operations on cotton in Central America (a pest management area not included in the AID program) and the level of resistance in malaria mosquitoes, yielded the following observations:

1. Anopheles albimanus collected in Haiti developed only a three-fold resistance to organophosphate and carbamate insecticides even with rigorous selection in the laboratory. On the other hand, A. albimanus collected in El Salvador already had a three-fold to four-fold resistance level and quickly developed levels over 30-fold with selection in the laboratory.

2. Good correlation exists between the spectrum of resistance found in mosquitoes in Central America and the types of insecticides used in agriculture.

3. Cotton insect pests have developed resistance in Central America, especially to parathion.

4. Mosquito populations are found to decline during the wet season. If agricultural pesticides were not used during that season, one would expect a rise in population.

5. The geographical range of resistance is complex. It is difficult to correlate the range directly with the amount and frequency of pesticide application because those records are often not kept. Resistance does seem to correlate with the size of holdings, however. Large holdings generally mean more applications and more spraying done by air rather than from the ground. Other factors are also important. For example, resistance is high in the center of Nicaragua where the insect population is geographically isolated and subjected to heavy treatments of pesticides.

6. Seasonal data show a rise and fall of resistance among mosquitoes paralleling the rate of use of agricultural pesticides. Where the pesticides have been used for a number of years, the resistance level fluctuates less with the seasons.

Exposing agricultural workers to pesticides--Agricultural workers exposed to pesticides during application and after crop treatment can and have been poisoned in LDC's. Each of the families of pesticides (chlorinated hydrocarbon insecticides, organophosphate insecticides, carbamate insecticides, and herbicides) that AID may finance for use in LDC's in the currently identified activities is discussed with regard to their past record and their potential for poisoning agricultural workers exposed to them.

Chlorinated hydrocarbon pesticides--Members of this family of pesticides included on AID's proposed activity list are BHC and endosulfan. As discussed in Appendix B, both BHC and endosulfan are significantly more toxic orally and dermally than DDT. Members of this family of pesticides are generally fat-soluble, and accumulate in the body fats of exposed individuals. The long-term effects of this accumulation as discerned from animal and human experiments and from retrospective epidemiological investigations of occupationally exposed individuals are uncertain. A review of published historical poisoning incidents has implicated BHC in a poisoning epidemic resulting from careless use of this pesticide around homes, while no poisoning episodes have been reported for endosulfan in LDC's.

Organophosphate insecticides--Members of this family of pesticides included on AID's list of candidates for future use include: monocrotophos, oxydemeton-methyl, parathion, and trichlorfon. Although there are wide variations in mammalian toxicity among various members of this family of pesticides, these compounds are generally absorbed readily by the gastrointestinal tract, lungs, and skin and therefore must be handled with appropriate safeguards. Recovery from an exposure is often slow (days) and is in part dependent upon the synthesis of the enzyme acetylcholinesterase. Since this synthesis is in turn dependent on adequate levels of appropriate amino acids in the body, nutritional status of the individual is quite important to recovery. In general, people subsisting on a low intake of completed protein can thus be expected to be more susceptible to poisoning and to recover more slowly following exposure. However, no data have been found to indicate that these chemicals elicit carcinogenic or teratogenic changes in mammals with repeated exposure. Since these pesticides are rapidly metabolized by the body to innocuous compounds, there are no known residue problems.

The most cited organophosphate in past poisoning incidents is parathion. A search of the literature revealed numerous incidents of poisonings from this pesticide involving suicidal, incidental and occupational exposure. Many of these incidents involved mass poisonings through inadvertent contamination of foodstuffs used for human consumption. The second most cited organophosphate is malathion. However, poisoning incidents involving this pesticide seem to stem mainly from suicidal intoxication, with only a few cases of occupational origin (such as the Pakistan episode, page 226).

Although the AID pest management program does not involve cotton production, a recent study of such activities yields some pertinent findings. In an ICAITI investigation of the consequences of pesticide use in Central American cotton production (25), it was established that organophosphorus pesticides caused the largest number of clinical poisonings. Chlorinated hydrocarbon and carbamate pesticides were of significantly less importance. In terms of overall morbidity rate (number of poisonings per 1,000 population) the range in 1973 was from 0.173 in Honduras to 4.92 in El Salvador. However, the largest number of poisonings occurred in cotton growing areas.

Deaths by pesticides ranged from 3 per million population in Guatemala to 22 per million in Honduras. The number of poisonings in El Salvador had been increasing dramatically from 1970 to a peak of 2,313 in 1972 but dropped significantly to 946 cases by 1974. This substantial improvement in the incidence of pesticide poisonings is attributed by ICAITI to an AID-sponsored seminar on proper pesticide management and corresponding support by government and others in the application of preventive measures to avoid poisoning (25). Factors which emerged as the major contributors to poisonings included:

1. Entrance of workers in the cotton fields within 72 hr after spraying.

2. Ingestion of food or water inside the cotton plantations.

3. Smoking inside the cotton plantations.

4. Holding cotton branches during harvest with the teeth.

5. Ingestion of wild greens that grow inside cotton fields.

6. Bathing in canals that meandered through cotton fields.

7. Failure to use personal protection equipment.

8. Walking barefoot on soils contaminated by pesticide spilling.

9. Failure to change contaminated clothing and to bathe.

10. Staying inside cotton plantations during spraying.

11. Dwellings and sheds too close to the cotton plantations.

12. Ignorance and illiteracy.

13. Occasionally, nonworkers are poisoned as a result of aircraft spraying over roads or settlements (villages and hamlets).

Many of the above factors contributing to pesticide poisoning were collaborated by the findings of a 1974 WHO survey of member nations (26). The conclusions emanating from this survey called for action through increased control of the dissemination and use of pesticides and through greater attention to education.

Carbamate pesticides--The only member of this family of pesticides included on AID's proposed activity list is carbaryl. Although this family of compounds is similar toxicologically to the organophosphates, most are not absorbed through the skin. Thus, the major route of occupational exposure is avoided. These compounds also form a much weaker bond with acetylcholinesterase that is readily broken by the body, thereby releasing the bound enzyme. Detoxification typically takes place naturally within a few hours followed by a complete absence of observable signs and symptoms of the intoxication.

Herbicides--Included in this category of pesticides for AID proposed activity are: alachlor, atrazine, cyanazine, and linuron. Toxicologically, these compounds have very little effect on animals or man because of their selected toxicity for plants. Furthermore, no long-term exposure effects are known to occur.

Pesticide residues in food--While the risk of acute toxicity of pesticides is of significant concern to the handler of these compounds, potential chronic risk is also of significance. The major route through which a population may be chronically exposed to pesticides is through consumption of residues in and on foods. Because of the greater persistence of organochlorides, exposure to this family of pesticides is of primary concern. However, there is also concern with the less persistent organophosphate and carbamate pesticides if the target food crops are harvested and consumed soon after pesticide application. Although it is generally held that pesticides applied under good agricultural practices and in accordance with manufacturer's label directions will produce residue levels within acceptable ranges, there are many variables which must be considered. The actual use of a given pesticide against a pest on a particular crop may vary considerably from region to region due to differences in ecology, climate, and cultural practices.

Physical factors that further influence the persistence of a chemical, and the possibility that residues may remain are: the amount of chemical applied; the formulation; the nature of the surface to which it is applied; exposure to weathering from wind, rain, etc.; chemical breakdown from high temperatures and humidity; photochemical reactions from sunlight; and the length of time the chemical is exposed to the above factors (28). Together, these factors may produce a variety of residue levels worldwide in foods at harvest.

In response to the concern over pesticide residue levels in food, many national and international groups have considered the problem and have established tolerance levels for various active ingredients. In the United States, the Food Protection Committee of the National Academy of Sciences - National Research Council produces a Food Chemicals Codex (29). This document contains standards for acceptable levels of food-grade chemicals and

is revised periodically to incorporate new data and new chemicals. Internationally, the Plant Production and Protection Division of FAO and WHO are jointly reviewing data on various pesticides in use around the world in order to establish acceptable daily intake levels, safe reentry periods, and preharvest withholding intervals (30). Additionally, pesticide residue tolerance levels in specified food commodities have been recommended for the purpose of protecting the consumer. Cumulatively, these laws and regulations are enabling food crop importing countries to check pesticide residue, and refuse any commodity which exceeds acceptable levels. In turn, the exporting countries are obliged to check residue levels prior to shipping. This ongoing vigilance against excessive residue levels in food ultimately has the effect of forcing the food producer to regulate more closely his use of pesticides. This development will tend to have a positive effect on poisoning potential, and on the environment, of the countries involved. However, the evolution of a consistent need for testing residue levels requires a corresponding development of laboratory facilities and capabilities including trained personnel and standard methods of assay designed to yield consistently accurate results.

In response to this recognized need, AID has established a UC/AID quality control program designed to assist 13 laboratories in five participating countries. Specific objectives of the program are as follows:

1. To maintain a continuing assessment of the accuracy and precision of analysis in the laboratories.

2. To provide a measure of precision of the analytical methods used.

3. To assess training needs within the analytical group.

4. To provide methodology aimed at increasing the proficiency of each laboratory.

5. To upgrade and equalize the quality of laboratory performance.

6. To provide a means of distribution of technology among the laboratories.

The University of Miami will function as the coordinating unit for the program. The participating laboratories will be sent residue samples to be analyzed for active ingredient and concentration. The Miami laboratory will then advise the laboratories of their accuracy and assist them in correcting deficiencies. The Miami laboratory is also prepared to provide training for qualified residue chemists who are able to come to Miami for the 1-year course. This AID-sponsored program is viewed as constituting a significant and timely positive step toward dealing with the international problem of residue in food, as well as pesticide management generally.

Overall, anticipated impacts on human health from use of pesticides in less developed countries under Alternative A as described above can be summarized as follows:

1. Definite though unquantifiable improvement in food output from pest management generally, thus providing the foundation for improved nutritional status and health and well-being overall.

2. Minimal poisoning potential or residue effects, but unknown impact on insect vector resistance development from use of chlorinated hydrocarbons.

3. Significant potential for poisoning from parathion, no long-term residue effects, and unknown impact on development of vector resistance from use of organophosphates.

4. Minimal poisoning potential but unknown long-term health effects and impacts on development of vector resistance from use of carbamates.

5. No known poisoning, long-term or resistance consideration from use of herbicides.

Environment--Maximizing agricultural production beyond current levels in less developed countries includes the use of pesticides. Total agricultural production lost to pests is very significant in countries producing only a subsistence level food supply. Insects, diseases, and weeds are estimated to reduce crop production in South America, Africa, and Asia by 33.0, 41.6, and 43.3%, respectively (31). Worldwide agricultural losses to pests (insects, diseases, weeds, and vertebrates) are estimated to be 48% in spite of controls. Preharvest losses are about 35% and postharvest losses are about 20% (32). To minimize the risk of crop loss and to ensure increased production, some less developed countries may have applied pesticides at times as "insurance," i.e., before pests actually appeared (33). AID also procures pesticides for plant protection when crop protection against any further losses is critical, i.e., where production is at the subsistence level at best.

Historically, AID has supplied pesticides primarily from the following four classes: organochlorine insecticides, organophosphate insecticides, carbamate insecticides, and herbicides. Further procurements, where not specified, would probably also be from these four classes. In some instances, proposed program documents state the pesticide required. However, quantities to be procured are not known as these often vary according to conditions of the program. More frequently, the specific chemical that will be required is not known at the inception of the program. Without quantitative and qualitative data on the specific pesticides, the magnitude of specific environmental effects which may result from all of the currently identified AID agricultural programs cannot be quantitatively assessed. Therefore, the

following paragraphs present a general discussion of the environmental effects which may occur from agricultural usage of the four previously mentioned pesticide classes.

The organochlorine insecticides represent 50% of all insecticides used in less developed countries (33). As a class, these pesticides are very persistent, with a duration of activity of 2 to 5 years (34). The most well-known pesticide of this class is DDT. However, AID does not plan use of this compound in any food production or preservation program. Other organochlorines (BHC and endosulfan) may be used for crop protection in Africa and Asia.

Organochlorines are readily adsorbed on soil (35). Their water solubility is low, confining residues in runoff from fields to soil particles. Once entering water systems either through runoff from treated fields, spray drift, or contaminated underground water, organochlorine residues are readily bound to bottom sediments. Organochlorines are highly toxic to lower aquatic organisms and to fish (35) as evidenced by reports of fish kills following treatment of rice with BHC, endosulfan, or other organochlorines (15,33). Binding of residues to bottom sediments may reduce the incidence of acute toxic impacts on aquatic organisms. BHC and other organochlorines have been reported to be degraded rapidly by anaerobic microorganisms in tropical rice soils under flooded conditions (37). However, the general persistence of residues and water turbulence may continually recycle the organochlorines in the system resulting in long-term, low-level exposure of organisms (33). Low concentrations of organochlorines often do not kill fish but may affect them upon long-term exposure. Fish resistance to disease may decrease; thyroid activity and reproduction (increased egg and fry mortality) may be adversely affected by organochlorines (38).

Acute toxicity to birds is low resulting in relatively few reported bird kills during organochlorine application. However, bird diets may be contaminated for extended periods by persistent residues. Organochlorines are highly lipophilic. Egg shell thinning is an important effect of some organochlorines in birds and has seriously affected reproductive success of some species.

Adverse impacts of organochlorines on wild mammals are generally not as frequent or as serious as impacts on birds and fish (36). Acute toxicity is low, reducing hazards of poisoning during field application. However, due to their high lipoid solubility, organochlorines will accumulate in body fat if a high proportion of the diet is contaminated with residues (38).

In contrast to the organochlorines, the organophosphates do not involve as severe long-term impacts because they are not as persistent. Their duration of activity is on the order of 1 to 12 weeks (34) although this period may be shorter in the tropics due to faster degradation under warm, humid

conditions (11,33,39). Although they are more selective and less persistent than organochlorines, organophosphates are often more toxic to warm-blooded animals (34) increasing the potential for wildlife poisoning during field application. Historically, AID has procured organophosphates for use in all geographic regions and anticipates use of the organophosphate, trichlorfon, in Africa.

Organophosphate insecticides are moderately to highly toxic to nontarget organisms. However, the period of exposure is relatively short because of their rapid degradation of residues. Organophosphates have a short life in water, soil, plants, and land organisms (40,41) and all are generally broken down to harmless substances (41). Field tests indicate that organophosphates may degrade in soil in rice fields so rapidly that they are uneconomical for use in less developed countries (37). Degradation may be even more rapid in the tropics because of higher temperature and humidity (11,33,39). Because of the rapid degradation of organophosphates, their effects on wildlife from use in agricultural programs largely will be limited to hazards of poisoning during application. Possible long-term impacts on environmental elements are discussed later in this subsection.

The carbamate insecticides also have a short environmental life. As a class, they are nonpersistent; their duration of activity is 1 to 12 weeks (34). Carbamates decompose rapidly in water and in sunlight. Residues are less persistent in river water than are organochlorines. Carbamate residues degraded rapidly in Nile River water (40). Degradation is rapid and occurs by both biological and nonbiological processes. Carbamate acute toxicity depends upon the compound. The toxicities to biological elements of carbaryl are summarized in Appendix B. There is no evidence of carbaryl buildup in food chains; therefore, impacts on wildlife appear to be limited to acute toxic exposure to carbamates during their application.

AID has provided limited amounts of herbicides for past food production programs. In general, the duration of activity is 1 to 18 months making herbicides moderately persistent (34). Persistence and carry-over do not seem to result in any known significant ecological disturbances (36). Hazard to nontarget aquatic and terrestrial organisms is generally low because of the low order of toxicity to birds, mammals, and aquatic organisms, and soil organisms (36,41). The most frequent adverse impact associated with agricultural use of herbicides is drift of spray onto sensitive, nontarget plants. Massive kills of aquatic plants resulting from misuse may also occur (36). Plant kills may have indirect adverse impacts on wildlife by destroying food supplies. The magnitude and duration of such an impact will depend on: (a) the frequency of herbicide use; (b) the selectivity of the herbicide; (c) the method of application; and (d) the degree of dependence of wildlife species on the affected plants as a food source.

Socioeconomics--The major objective of AID's pest management activities in food production and preservation is to reduce losses to pests, thereby increasing the available food supply in LDC's. The extent to which AID's activities accomplish this objective is the major positive socioeconomic impact of their pest management program. The United States (through AID) is only one of many national and international organizations that contribute to overall development programs in LDC's, and AID pest management activities are only one small element in the overall development program. Consequently, it is impossible to factor out the proportion of benefits directly attributable to AID pest management activities. However, controlling pest losses is an integral part of a socioeconomic development program in LDC's, and effective pest management activities can have a substantial impact on other socioeconomic factors.

The need to increase available food supplies is well documented (42), as discussed on page 124. Malnutrition is one of the major factors inhibiting development in the LDC's, and any progress toward relieving the effects of malnutrition must be considered a major positive socioeconomic impact. The general health and nutrition of the people in a given country have a direct effect on productivity and economic growth. Improved health and nutrition and the related increase in life expectancy are factors that cannot be quantified in economic terms, but the value of these improvements to those affected is extremely high. Impacts of this type resulting from AID activities are magnified because AID programs are designed to benefit the rural poor in the most disadvantaged countries.

The effect of pests on agricultural productivity is also well documented. Crop losses to pests vary from region to region depending on a number of different factors, but it has been estimated that the worldwide annual loss of potential productivity to pests is approximately 48%. In most less developed countries, losses approximate this figure.

In addition to impacts on the general economy through the improved general health and well-being of the people, a number of other socioeconomic impacts result from controlling pest losses. Many of the rural poor in LDC's are subsistence farmers working small plots of land, 5 ha or less in size (2, 6). Pest control on these plots can result in substantial increases in production yields which enables these farmers to devote less acreage to subsistence needs and more acreage to cash crops thereby increasing rural incomes.

Increasing agricultural production has an effect on other sectors of the economy. In a basic agrarian economy like that of most LDC's a large proportion of the labor force is employed in agriculture or agriculture-related industries. Increasing agricultural production contributes to the expansion of agriculture-related industries such as food processing. In addition, in countries with a basic agrarian economy, agricultural exports are the most important component of foreign exchange. It is essential in

an agrarian economy to develop these sectors of the economy to achieve economic self-sufficiency. To accomplish this, it is necessary to increase agricultural production beyond the subsistence level, and effective pest management is an integral part of this process.

Pest control, particularly through the use of pesticides, is just one of a number of agricultural activities that function interdependently to increase agricultural production. Not only do inputs such as higher yielding crop varieties, irrigation, fertilizers, and other costly advances create a situation that requires effective pest control, but the gains made through these inputs may be negated unless damages caused by pests can be kept below economic threshold levels.

AID pest management programs relating to trypanosomiasis are discussed at length under health programs. However, because the disease affects both man and livestock, its control is important to agriculture. Programs to control vectors of the disease protect existing livestock and open additional land area for expanded livestock production. One conservative estimate of the land area denied to livestock production in Africa due to trypanosomiasis is 5 million square kilometers (12). Controlling the disease vectors in a given area also enables people to relocate in that area and put previously idle land into agricultural production.

Not all of the socioeconomic impacts of AID pest management activities are positive. A number of direct and indirect adverse impacts also result that are primarily associated with pesticide activities. The most direct adverse threats of Alternative A are the potential health effects and loss of life that could occur with the misuse of pesticides. These include both acute and chronic effects resulting from exposure through application or consumption of contaminated substances, and have been discussed previously under human health. While the most traumatic effect of these impacts is in the area of human health, they must also be considered socioeconomic impacts. Losses to the economy from such impacts include the direct costs of prevention, detection, treatment, and rehabilitation, and the indirect costs of loss of productive output via death and disability.

Another socioeconomic concern of pesticide use is the effect of repeated pesticide applications on the agricultural base. While the amounts of pesticides procured through AID financing are minor in comparison to the total amounts used in most less developed countries, they may contribute to a situation that could lead to an unacceptable buildup of pesticide residues in soil. This could cause pesticide residues to exceed acceptable limits in some crops that readily absorb pesticides from soil, such as potatoes and carrots.

Continuous use of pesticides can also have an effect on economically beneficial species as well as pests. In addition to the loss of natural predators, beneficial soil microorganisms and pollinator species may decline as a result of pesticide use.

There is concern in less developed countries over pesticide residues in agricultural products to be exported. AID program activities have a minor impact in this regard because AID programs and any associated pesticide use are designed to benefit rural small farmers, and increases in agricultural production from their activities go primarily for domestic consumption. In instances in which cash crops destined for export benefit from AID pest management activities, pesticide residues are monitored to prevent levels from exceeding tolerable limits (28,43).

While AID efforts are designed to benefit the rural poor, there is concern that under certain social and economic conditions, some projects may not meet this goal. For example, in the United States, resources released from agricultural production because of chemical pesticides are considered a benefit, enabling capital and labor to be shifted to other pursuits. In LDC's, however, where unemployment is a major problem and a large percentage of the labor force works in agriculture, the use of chemical pesticides may displace labor in the field, adding to unemployment. Workers displaced are usually without skills to move immediately to nonagricultural occupations, and adequate administrative and institutional machinery to train them are unavailable.

Several types of AID activities benefit the agricultural sector in some recipient countries, with the objective of improving the entire economy through the agricultural base. Examples of these types of activities are the Commodity Import Programs in Egypt and Israel, and Agricultural Credit programs in Latin America. The objective of these programs is to improve the overall economy.

Any change introduced to rural small farmers in agricultural technology is accepted reluctantly from a social standpoint in LDC's. The more drastic and obvious the change, the greater is the social impact. Consequently, anything mechanized, or anything requiring a change in the normal farming routine such as the application of pesticides with spray equipment, is not as readily accepted as less obvious changes such as the introduction of disease-resistant species.

Social systems of less developed countries depend primarily on the degree of economic development. As less developed countries progress toward agricultural self-sufficiency and more affluent economies, changes in the degree of social organization come about. With better fed, healthier, and more productive populations, countries become interested in improving quantity and quality of social services, such as education systems, transportation network, communication systems, municipal utilities and services, and cultural programs. Literacy rates usually improve as economic development increases productivity and permits resources to be directed toward quality of life factors other than survival.

In agrarian economies such as most less developed countries have, family units are usually close-knit with most members engaged in farming activities. As agricultural self-sufficiency is achieved and improved, agricultural exports become possible and industrial or nonagricultural economies begin to emerge. While this may enchance GNP, it may adversely affect the quality of traditional family life by enticing people to work and live in urban areas.

Although most of these social effects are likely to happen with increased economic development, the proportional role of AID-supported pest management programs in causing them cannot be determined. In view of the small proportion of AID pest management programs within the overall world programs for less developed countries, social impacts, both beneficial and adverse, would be slight. In less developed countries with the most critical need for food production assistance, social impacts attributed to AID pest management programs for food production would be beneficial with no obvious adverse effects. However, in countries which are on the verge of developing industrial-commercial economies, or already have them, AID programs could, in principle, be accountable for some of the adverse social effects associated with urbanization and industrialization.

Extraterritorial global and United States impacts--Human health impacts on the United States and extraterritorial global areas resulting from AID-sponsored pesticides under Alternative A may result from: (a) increased residues in foods exported from AID-recipient countries, (b) occupational accidents to workers involved in the production, transportation, and storage of the pesticides financed by AID for export from the United States to the less developed countries, and (c) spread of pest resistance (agricultural and disease vector) and residues from these countries to other global areas. Residues of the more persistent pesticides in various food products (most notably dairy foods and meats) may represent a health threat if levels are too high.

The potential global impacts that might be incurred from pesticide use in agriculture are influenced by the chemicals' properties (persistence, volatility, and transport), as well as use pattern, magnitude of use, and

the degree to which the pesticide is correctly used. In general, the portion of pesticides financed through AID is small compared to total pesticide use in major global areas. Therefore only a proportionally small degree of any potential global impact of pesticides can be ascribed to AID's pest management program.

Pesticide residues are not necessarily confined to the site of application. Transport from the target area may occur by (a) drift of spray during application; (b) transport of residues in runoff water or sediments; (c) wind erosion of dust particles to which the pesticides are adsorbed; (d) volatilization resulting in airborne residues; (e) leaching of residues through soil to underground water; or (f) migration of pesticide-contaminated animals (33,34,43).

Regardless of whether residues are transported by air or water, the sea is considered to be a major sink for persistent pesticide residues. For example, one estimate has been made that 25% of all DDT manufactured to date has found its way to the ocean (40). It should be noted, however, that AID does not anticipate use of DDT in the food production and preservation program. The organophosphates, carbamate, and herbicides to be financed are generally not chemically persistent but are biodegraded in the environment; it is probable that residues would not be significant problems. Residues of organochlorine insecticides are global in occurrence (38). AID anticipates using limited quantities of organochlorines for agricultural application. However, these quantities are very small on a worldwide scale and should not significantly contribute to the global load of organochlorine residues.

There is potential for the United States to be affected in several ways by AID pesticide activities. First, most AID-procured pesticides are produced in the United States. Theoretically, a portion of the United States environmental impacts resulting from pesticide manufacture could be attributed to AID pesticide purchases. However, AID purchases only a small portion of the United States production of these pesticides. For example, AID procurement of malathion in 1973 was only 0.03% of the total estimated United States production (see Appendix B).

AID pesticide activities may indirectly affect migratory waterfowl. Many waterfowl species summering and breeding in the United States overwinter in Central America and northern South America, and several European populations winter in Africa and Asia (44,45). However, the current and future impact, if any, on waterfowl of AID Latin American and African programs cannot be quantitatively assessed because of lack of data on which countries will receive pesticides, or the quantities and specific chemicals that will be supplied.

Socioeconomic impacts in the United States from AID pest management activities are extremely minute when considered in relation to the aggregates to which they contribute. However, the impacts are noticeable from a microeconomic standpoint, and must be considered in this analysis. AID activities require the expenditure of funds in the United States for a number of things, including commodities used in recipient countries such as pesticides, equipment used for training and demonstration purposes, materials and equipment used for construction of related facilities, etc. While these expenditures are minor from a national accounting standpoint with respect to GNP and balance of payments, they contribute to the sales volumes of the suppliers, and related employment and income effects.

Technical assistance, training, and research activities provide employment for a large number of academic and professional people and related support staff in the United States, and provide financial support for a number of academic institutions and private research organizations.

Advances in agricultural technology developed through AID-sponsored research activities may benefit the United States as well as recipient countries. For example, a high protein variety of seed developed under an AID research project has been distributed to United States seed dealers (46). Additionally, the United States imports agricultural products from many AID-recipient countries. AID activities that contribute to the development of in-country pest control capabilities benefit the producers of these products, and affect their general market availability.

Short-term benefits versus long-term effects--Two health factors must be considered in evaluating short-term benefits versus long-term effects under Alternative A: (a) rise in food production versus an increase in pest resistance; and (b) an increase in food output and therefore nutritional status of a people, versus an increase in the number of people to be fed. It is a well-established fact that the use of appropriate pesticides can bring about marked increases in food production and preservation. However, less well understood is the longer-term implication of consistent pesticide use resulting in development of resistance and disruption of natural predator/prey balances. These longer-term impacts may represent countering forces which will subtract from the short-term gains in economics and health. Increasing the nutritional status of people in a less developed country may also effectively lower the death rate (notably infant mortality rate), placing added burdens on that country's abilities to sustain its people for the long term.

The most obvious short-term benefit from pesticide application is the reduction of crop loss from pests. Crop yield is estimated to increase an average of 30 to 40% above levels without pesticide use (40). Such increases are extremely important in lesser developed countries where nutritional levels and caloric intake are low.

Pesticide application may be a short-term benefit to a particular species should their competitors be eliminated. However, shifting a species' competitive advantage may result in long-term adverse effects on agriculture. One of the first effects of pesticide application is disruption of host-predator and parasite relationships (40). Examples of such disruption occurred in Ceylon tea production (34) and Latin American cotton production (25). Here chemicals applied to control the crops' primary pests also killed beneficial predators and parasites which formerly held secondary pests in check. As a result, more and more pesticides were required to control primary and secondary pests. Termination of pesticide application did not necessarily result in return to the host-predator equilibrium.

Residues of persistent chemicals, e.g., organochlorines, can continue to kill beneficial species. Application of less persistent chemicals (organophosphates and carbamates) does not necessarily minimize effects. More frequent applications of less persistent pesticides may be required for control of the primary pests, adversely affecting beneficial insect populations with each application. Relatively nonpersistent chemicals may be present over a long period of time if repeatedly applied (33). Many organophosphates and carbamates are systemic; i.e., they penetrate into the plant. Therefore, beneficial predators and parasites on the plant but not feeding on it may not be exposed to residues (41). The adverse effects may therefore be limited to destroying beneficial insects during and immediately following application of the organophosphate and carbamates.

One well-known long-term effect of pesticides on wildlife is bioconcentration of residues in the food chain. Less persistent compounds do not appear to bioconcentrate. Unlike organochlorines, the organophosphates are not known to accumulate in body fat (47). Neither organophosphate nor carbamate residues bioconcentrate in the food chain (40). After 20 years of use, no long-term adverse effects of organophosphates due to persistence or bioconcentration have been noted (41).

The persistence and carry-over of herbicide residues are generally not significant. However, herbicides have not been used over as long a period, or as widely, as insecticides in LDC's, and, although few ecological disturbances have been noted from herbicide use in the past, herbicides can affect nontarget plant communities and thereby indirectly affect wildlife (36). Changes in species composition to more resistant ones indicates that problems may develop with herbicides similar to those of insecticides in the long term if large amounts of herbicides are applied frequently in the future. AID does not anticipate supplying significant amounts of herbicides for agricultural purposes, and long-term adverse affects from AID-financed herbicides should be minimal.

Where AID's pest management program in food production and preservation involves pesticide activities, there is a potential for eroding the agricultural base and developing resistance among target pests and nontarget insects, creating a situation of decreasing benefits and increasing costs over time. Spectacular production increases in the short term may mask these long-term effects. However, the initial level of benefits gained may enable LDC's to finance increasing costs in the long term, and may even be necessary

as they progress toward the development of other sectors of their economy so as to generate overall economic growth and development.

Unavoidable adverse effects--One unavoidable adverse effect identified for the use of pesticides for food production is the development of resistance of disease vectors and agricultural pests. Human poisoning incidents stemming from pesticide use are viewed as avoidable.

Pesticides are by definition poisonous to some biological organisms. Using the available application techniques, a certain amount of drift of pesticide spray out of the target area is unavoidable (33). Wildlife within and near the target area will therefore be exposed to pesticides during their use. This exposure route is unavoidable; the severity of impact depends upon the toxicity of pesticides applied and the sensitivity of the species.

Application of persistent pesticides also results in certain unavoidable effects. Organochlorine residues are persistent and do build up in food chains (33,38,40). Some deterioration of the agricultural base and some loss of economically beneficial organisms are unavoidable under Alternative A. The magnitude of these effects can be limited by proper use and application methods.

As previously discussed, control of disease vectors affecting man and livestock will allow expansion of humans and their livestock into regions freed of disease. Such expansion may result in unavoidable stress on marginal lands from livestock herds, leading to further land deterioration.

Irreversible and irretrievable commitments of resources--AID procurement of pesticides has been and will continue to be a small portion of the total United States pesticide production that is exported. A certain degree of resource commitment, i.e., energy, petroleum, chemicals, etc., is necessary for the production and transportation of pesticides. A percentage of resource commitment could be attributed to AID equal to the percent of total pesticide production AID purchases. This commitment of resources would be small on a worldwide or U.S. scale.

The development of resistance in certain pests can be considered an irreversible and irretrievable commitment of resources in the sense that it decreases options available to society. Alternative methods required to control resistant pests may be more costly and less effective.

Agricultural expansion may so alter the ecosystem that return to its former state may be impossible. As humans settle and develop land, wildlife habitat will be destroyed and wildlife species may be threatened.

Impacts of Alternative B--

For Alternative B, pesticide activity for food production and preservation programs in any region would also be subjected to a "risk-benefit" evaluation as set forth in Chapter III, page 214. This evaluation will consider the potential benefits conferred by the use of the proposed pesticide, the availability of efficacious substitutes (pesticides or pest management activities), costs of control, and the extent of human and environmental risks involved. The training and technical assistance and other pesticide management activities would remain unaltered.

The overall impacts of Alternative B should be more beneficial to regions that receive AID-financed pesticides than the impacts of Alternative A for the simple reason that the analyses will be aimed at optimizing the benefits of pesticide activity in these regions while minimizing the disbenefits. At the minimum AID would proceed to finance pesticides for agricultural use in the same manner as outlined in Alternative A, should the analyses show that no increase in benefits nor decrease in disbenefits would be forthcoming from an alternate course of action. In this case the pesticides financed under Alternative B would be the same as those for Alternative A, and the impacts of the two alternatives would be identical.

In the event that the analyses showed an alternate course of action would be more beneficial to the recipient regions, then such action would be taken to the benefit of the recipient of the pesticides. This would involve trade-offs between health, social, environmental, and economic considerations, but the overall effect would be beneficial.

The impacts Alternative B would have, in relationship to the impacts of Alternative A discussed previously, on each of the seven organizational areas are discussed below. Without complete quantitative and qualitative data for the currently identified AID pesticide procurements for food production and preservation programs, it is impossible to quantitatively forecast the increase in health, environmental, and socioeconomic benefits that this alternative would provide. However, it is conclusive that this alternative is preferred to Alternative A with respect to impact considerations in that the addition of an analysis to the current pest management procedures will lead AID closer to optimizing the benefits that pesticide activities provide recipient countries.

Human health--Under this alternative, analyses will be performed on all pesticide activities. These analyses may result in shifting to some extent the selection of AID-financed pesticides from the more persistent chlorinated hydrocarbons to the less persistent organophosphates and carbamates.

The resulting human health impact changes from Alternatives A to B will likely be: (a) a slightly increased potential for poisoning where selections tend toward the less persistent but more acutely toxic compounds, and (b) an increased potential for development of resistance among disease vectors to DDT-substitute pesticides.

Environment--Under Alternative B, pesticide procurement may shift to some extent toward the less persistent chemicals, based on an analysis of each request for pesticide financing. Should a less persistent chemical (organophosphate or carbamate) give the best overall result within the specific characteristics of the proposed program, the less persistent chemical would be provided. However, for some uses, the advantages of a persistent chemical outweight the environmental benefits of a less persistent chemical in LDC's. AID would therefore still procure some organochlorines, but possibly less frequently than when operating under Alternative A.

Such a shift in emphasis will cause a commensurate decrease in the magnitude of the adverse impacts of organochlorines. Less dependence on organochlorines will reduce the contribution of organochlorine residues in the food chain. The organophosphates and carbamates are generally not persistent and do not bioconcentrate. The impacts of Alternative B will be analogous to Alternative A for the four pesticide types except that the magnitude of impacts resulting from organochlorines will decrease by replacing some applications with less persistent compounds.

Socioeconomics--Increased agricultural production attributable to AID pest management activities would remain approximately the same under Alternative B as under Alternative A, and socioeconomic impacts generated from this increase would also remain similar.

A shift toward less persistent pesticides, to whatever degree, would lower the potential for deteriorating the agricultural base because of persistent residues. However, a reliance on less persistent pesticides may require more numerous and frequent applications to achieve the same level of effectiveness, thereby creating a persistence-like effect in association with the more acutely toxic characteristic. A shift toward less persistent pesticides can be expected to increase the cost of pest control.

Analyses of proposed pesticide activities would have a tendency to lessen adverse effects by eliminating pesticide use in situations in which hazards outweigh benefits. Analyses of this type would also help in exposing any hidden adverse effects associated with the use of particular pesticide procurements.

Extraterritorial global and United States impacts--Health impacts under this alternative would differ from those previously delineated under Alternative A only to the extent that some organochlorines may be replaced by other less persistent compounds. This would have the effect of diminishing both the food residue problem and the problem of increasing vector resistance to organochlorine pesticides as a class.

Extraterritorial global and United States impacts resulting under Alternative B may be of less magnitude compared to impacts associated with Alternative A. The organophosphates and carbamates degrade rapidly and do not build up in food chains as do organochlorines. Thus, movement from the application site should be reduced.

Short-term benefits versus long-term effects--Health considerations under this alternative would be similar to those under Alternative A. The potential for human intoxication, however, would be increased to the extent that more acutely toxic pesticides are substituted for persistent compounds.

The short-term benefit of using less persistent pesticides would be the same as under Alternative A, i.e., increased crop yield. Most of the long-term effects would also be the same. Any shift to less persistent pesticides would lessen organochlorine residues and therefore the potential for bioconcentration in the food chain. The long-term impacts of herbicides would be the same as under Alternative A.

Unavoidable adverse effects--Unavoidable effects under this alternative would still include the potential development of resistance. However, from the standpoint of malaria control efforts, restricted use of persistent organochlorines would have the potential of a short-term beneficial effect on the problem of resistance.

Toxic effects of pesticides on wildlife during application would be the same as under Alternative A. The unavoidable problems of persistent residues and bioconcentration in food chains would be less than under Alternative A with any shift from organochlorines to organophosphates and carbamates.

Irreversible and irretrievable commitments of resources--Resource commitments resulting from implementation of Alternative B would be essentially the same as those discussed for Alternative A.

Impacts of Alternative C--

Human health--Under this alternative, any chemical not registered for use in the United States or whose use has been cancelled or suspended would not be procured by AID for agricultural use. To the extent that persistent, less toxic compounds are not available and more acutely toxic substitutes are required, the potential for poisonings is again increased. In other respects, the impacts on human health would be analogous to those of Alternative B.

Environment--Many agricultural pesticide activities may be severely limited under implementation of Alternative C. AID would authorize pesticide application to crops for which the pesticide use is registered in the United States. Many crops important in less developed countries are not grown in the United States and pesticides are not registered for the control of their economic pests. AID would not supply any pesticides which have been suspended or cancelled for use in the United States. Therefore, pesticides cancelled because of their adverse environmental effects would not be used in AID agricultural programs. Environmental effects of the four classes of pesticides would be the same as under Alternative A except that specific cancelled chemicals (e.g., aldrin) would not be provided for agricultural purposes.

Socioeconomics--By limiting AID's pesticide activities to those active ingredients registered for use in the United States and prohibiting the use of cancelled or suspended pesticides, AID's ability to contribute to increased agricultural production through the control of pest losses in comparison to Alternative A would be reduced. This effect would produce a corresponding reduction in positive socioeconomic impacts associated with an increase in agricultural production as described in Alternative A.

The resultant shift in emphasis toward less persistent, more toxic chemicals may reduce adverse impacts on the agricultural base and lessen the potential for a buildup of residues in the soil. The resultant shift may also lessen the potential for residues on agricultural products.

To the extent that other pest management projects, training, technical assistance, and research in pest management contribute to increased agricultural production, AID's program impacts would remain the same as in Alternative A. However, AID's reduced involvement in pesticide activities may lessen its ability to influence positively the socioeconomic impacts associated with the proper use and handling of pesticides.

Extraterritorial global and United States impacts--Health impacts under this alternative would be essentially the same as discussed under Alternative B, since more persistent pesticides would most probably be curtailed for agricultural uses.

Many of the pesticides AID would not procure under Alternative C are the more persistent compounds which have been suspended or cancelled for agricultural use in the United States. Persistent compounds generally are the class responsible for known global effects. Slow degradation and high lipid solubility allow residues to be transported from the application site and potentially to become concentrated in food chains. Restricting procurement to compounds registered in the United States would favor providing less persistent pesticides more frequently than persistent compounds, reducing the quantities of persistent residues available for global transport.

Short-term benefits versus long-term effects--Health considerations under Alternative C would be the same as discussed under Alternative A.

Environmental effects of Alternative C implementation would be the same as under Alternatives A and B. The potential for disruption of beneficial insect populations would still exist; wildlife in or near the target site would be exposed to pesticides during their application.

Unavoidable adverse effects--The unavoidable environmental effects under Alternative C would be similar to those discussed for Alternatives A and B.

Irreversible and irretrievable commitments of resources--Resource commitments for AID pest management programs under Alternative C would be the same as those discussed for Alternative A, but would probably be reduced in magnitude.

Impacts of Alternative D--

Human health--The relationship between a country's ability to feed its people and the health and well-being of those people is a direct and obvious one. Whether this results from direct consumption of domestically grown products, through revenue obtained from export of food products, or some combination of these, the use of pesticides is generally accepted as one very important factor in overall efforts toward increasing production through control of pests. Therefore, the removal of this element of the pest management program would greatly reduce the effectiveness of the AID program.

At the same time the negative human health impacts of pest and disease vector resistance, worker poisoning, food residues, and environmental contamination would be avoided.

Environment--AID would provide no pesticides to recipient countries if operating under the guidelines of Alternative D. Therefore, environmental impacts of pesticide use discussed under Alternative A attributable to AID pesticide activities would not occur. AID would continue to lend technical assistance, training, and research programs in the pest management area. These activities would continue AID's positive role in promoting the proper pesticide usage and minimization of adverse impacts on the environment from pesticide activity. However, the effectiveness of AID in this role may well be reduced by its elimination of pesticide activity.

Socioeconomics--None of the socioeconomic benefits and disbenefits attributable to AID-financed pesticides for agricultural use would occur under this alternative. The economic benefits of pesticide inputs, increased agricultural output through the control of pests, protection of

stored products, and the economic disbenefits of pesticide residues in food, destruction and injury to economically important birds, fish, and wildlife, and substitution of pesticides for labor employment in subsistence agriculture that AID-financed pesticides contribute to under Alternative A would not occur. The social benefits of increasing nutrition and of elevating people in subsistence economies to less labor-intensive agriculture in AID assistance areas would be foregone to the extent that AID-financed pesticides contribute to these benefits.

Training, technical assistance, and other pest management activities would continue as under Alternative A, but the nature of these activities would probably change. More emphasis would be placed upon agricultural pest control practices that do not involve pesticides, such as cultural practices and other integrated pest management techniques. These activities would continue to provide socioeconomic benefits to the AID assistance areas similar to those discussed under Alternative A.

Extraterritorial global and United States impacts--No specific impacts on global or United States environment attributable to AID are seen under this alternative since no pesticides would be provided or funded.

However, AID would continue to have a positive influence on efficient pesticide usage through its training, technical assistance programs, and to some extent through research on pest management.

Short-term benefits versus long-term effects--The only health consideration would be the probable lack of significant improvement in nutrition and, therefore, health status of some less developed countries through restrictions against pesticides.

No long-term adverse effects on the environment of AID pesticide activities would occur under Alternative D. The long-term effects of other pest management activities would be potentially environmentally beneficial. Training and technical assistance would influence environmentally sound methods of pest control methods. Continued research programs would lead toward development of pest management programs without pesticides and insect and disease resistant crop varieties.

Unavoidable adverse effects--No significant unavoidable adverse effects would be attributable to AID. However, the potential would exist for an increase in the level and degree of malnutrition brought about by decreased food production and preservation.

No unavoidable adverse effects on wildlife associated with agricultural pesticide application would occur under Alternative D. However, since the less developed countries receive pesticides from other sources, wildlife would continue to be exposed to pesticides during their application and to the persistent residues which may result.

Irreversible and irretrievable commitments of resources--Resource commitments by the United States for the manufacture, transport, distribution, and application of pesticides would not be required under Alternative D, nor would AID contribute to the possible displacement and injury of any wildlife species through the use of pesticides.

Impacts of Alternative E--

Human health--Under this alternative, all AID-sponsored pest management activities would cease. This would obviously be an undesirable alternative from the standpoint of public health. Without AID participation in a less developed country's pest management activities, the world would lose a powerful positive influence toward better and safer methods of controlling pests. As demonstrated in El Salvador, AID-sponsored seminars on proper pesticide management hold great potential for decreasing the number of poisonings and realizing the intended benefits of pest management. Unless proposed AID pest management activities in the area of food production and preservation are assumed by another responsible organization, the health and well-being of the people involved can be expected to be adversely affected. Specific types of impacts to be expected include an increase in acute poisoning incidents due to a lack of training and technical assistance, and a decline in food production and thereby nutrition due to losses caused by pests.

Environment--AID would not supply pesticides, thus eliminating environmental effects discussed under Alternative A. AID would not fund any technical assistance, training, or research pest management programs. This action would result in no direct environmental effects for which AID would be accountable.

Socioeconomics--No socioeconomic impacts for which AID would be accountable would result from Alternative E. However, the termination of technical assistance, training programs, and other pest management activities would eliminate the socioeconomic benefits that these activities provide to recipient countries and regions (discussed under Alternative A).

Extraterritorial global and United States impacts--No health impacts on the United States are seen under this alternative.

AID would not contribute to the global impacts of pesticide use since under Alternative E they would not conduct any pest management programs. Further, any impacts on migratory waterfowl and on United States wildlife resulting from pesticide manufacture (as discussed under Alternative A) would not be attributable to AID. Costs of certain agricultural products imported by the United States would increase.

Other impacts--No short-term benefits, long-term effects, unavoidable adverse effects, or irreversible and irretrievable commitments of resources would result from this alternative.

SUMMARY OF IMPACTS OF ALTERNATIVE PEST MANAGEMENT PROGRAMS

Rational analysis of alternative pest management programs to be supported by AID requires the use of a comprehensive system for rating, comparing, and displaying relative impacts. However, since this programmatic environmental statement addresses extremely broad, multinational pest management programs involving several types of pest management activities in numerous countries for which few quantitative data are available, an abstract impact rating system has been used.

The five alternatives, A through E, were evaluated as to their overall beneficial or adverse effects on five major impact indicators. These five areas were: human health, environment, economics, agriculture, and social concerns. The overall rating scheme consisted of nine consecutive values from +4 through -4 expressed as follows:

++++ Major beneficial impact

+++ Moderate beneficial impact

++ Minor beneficial impact

+ Slight beneficial impact

0 No identifiable impact

- Slight adverse impact

-- Minor adverse impact

--- Moderate adverse impact

---- Major adverse impact

To display the comparative rating of alternative program impacts on the five indicators by overall geographic areas, four tables were constructed. These tables display relative magnitude and direction of impacts which can be attributed to the AID pest management programs. The four tables address the following topics:

Table 54 - Comparison of Impacts of Alternative Pest Management Programs for Public Health on Recipient Countries

Table 55 - Comparison of Impacts of Alternative Pest Management Programs for Public Health on the United States and Extraterritorial Global Areas

Table 54: Comparison of Impacts of Alternative Pest Management Programs for Public Health on Recipient Countries

Alternative	Program Elements	General Impact Areas: Human Health	Environment	Economics	Agriculture	Social
A	Pesticide Activities[a/] Other Pest Management Activities, Training/Technical Assistance, and Research as described for the currently identified AID Pest Management Program (see Chapter II)	+++	--	++	+	++
B	"Modified" Pesticide Activities;[b/] with full Other Pest Management Activities, Training/Technical Assistance, and Research	++++	-	++	+	++
C	"Restricted" Pesticide Activities;[c/] with full Other Pest Management Activities, Training/Technical Assistance; and Research	+++	--	++	+	++
D	No Pesticide Activities; with full Other Pest Management Activities, Training/Technical Assistance, and Research	+	-	+	+	+
E	No pest management program	0	0	0	0	0

Impact Rating System

++++ Major beneficial impact
+++ Moderate beneficial impact
++ Minor beneficial impact
+ Slight beneficial impact
0 No identifiable impact
- Slight adverse impact
-- Minor adverse impact
--- Moderate adverse impact
---- Major adverse impact

a/ Pesticide activity is defined to include all activities conducted, supported, financed, or otherwise assisted by AID for the procurement or use of pesticides, but does not include pesticide research and pesticide regulatory activities.

b/ AID Regulations (AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975, except that the use of the historical commodity eligibility list for pesticides would not apply), Regulation No. 16 (Federal Register, 41(127):26913-26919, June 30, 1976), plus "risk-benefit" analysis of each pesticide activity.

c/ AID Regulations (AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975, except that the use of the historical commodity eligibility list for pesticides would not apply), Regulation No. 16 (Federal Register, 41(127):26913-26919, June 30, 1976), plus the restrictions of the Stipulation and Court Order of December 5, 1975.

Table 55: Comparison of Impacts of Alternative Pest Management Programs for Public Health on the United States and Extraterritorial Global Areas

Alternative	Program Elements	General Impact Areas: Human Health	Environment	Economics	Agriculture	Social
A	Pesticide Activities[a/] Other Pest Management Activities, Training/ Technical Assistance, and Research as described for the currently identified AID Pest Management Program (see Chapter II)	+	-	+	0	0
B	"Modified" Pesticide Activities;[b/] with full Other Pest Management Activities, Training/Technical Assistance, and Research	+	0	+	0	0
C	"Restricted" Pesticide Activities;[c/] with full Other Pest Management Activities, Training/Technical Assistance; and Research	+	-	+	0	0
D	No Pesticide Activities; with full Other Pest Management Activities, Training/ Technical Assistance, and Research	+	0	0	0	0
E	No pest management program	0	0	0	0	0

Impact Rating System

++++ Major beneficial impact
+++ Moderate beneficial impact
++ Minor beneficial impact
+ Slight beneficial impact
0 No identifiable impact
- Slight adverse impact
-- Minor adverse impact
--- Moderate adverse impact
---- Major adverse impact

a/ Pesticide activity is defined to include all activities conducted, supported, financed, or otherwise assisted by AID for the procurement or use of pesticides, but does not include pesticide research and pesticide regulatory activities.

b/ AID Regulations (AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975, except that the use of the historical commodity eligibility list for pesticides would not apply), Regulation No. 16 (Federal Register, 41(127):26913-26919, June 30, 1976), plus "risk-benefit" analysis of each pesticide activity.

c/ AID Regulations (AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975, except that the use of the historical commodity eligibility list for pesticides would not apply), Regulation No. 16 (Federal Register, 41(127):26913-26919, June 30, 1976), plus the restrictions of the Stipulation and Court Order of December 5, 1975.

Table 56 - Comparison of Impacts of Alternative Pest Management Programs for Food Production and Preservation on Recipient Countries

Table 57 - Comparison of Impacts of Alternative Pest Management Programs for Food Production and Preservation on the United States and Extraterritorial Global Areas

In rating the overall impacts of alternatives under this system it was assumed that Alternative E, no AID program for pest management, represented the baseline situation under which no impacts, beneficial or adverse, could be attributed to AID. However, Alternative E, in all cases, would avoid some monetary costs and reduce commitment of resources.

In general for recipient countries, as well as for the United States and extraterritorial global areas, Alternative B would appear to have the most positive impact in the five indicator areas for both public health and food production program areas. However, there are many elements of the five impact areas which must be considered in detail in developing specific pest management programs for individual regions, countries, or geographic areas. These considerations may include pests to be controlled, crops to be treated, application techniques, cost, available supplies of materials, etc. Further, the relative importance of the major indicators and their component parts must be considered. Such considerations must be made integral parts of any analysis system and should also be addressed in any system designed to identify the "best" program for a given project or program area.

Table 56: Comparison of Impacts of Alternative Pest Management Programs for Food Production and Preservation on Recipient Countries

Alternative	Program Elements	General Impact Areas: Human Health	Environment	Economics	Agriculture	Social
A	Pesticide Activities[a/] Other Pest Management Activities, Training/Technical Assistance, and Research as described for the currently identified AID Pest Management Program (see Chapter II)	++	---	+++	+++	+++
B	"Modified" Pesticide Activities;[b/] with full Other Pest Management Activities, Training/Technical Assistance, and Research	+++	--	+++	+++	+++
C	"Restricted" Pesticide Activities;[c/] with full Other Pest Management Activities, Training/Technical Assistance; and Research	++	-	++	++	++
D	No Pesticide Activities; with full Other Pest Management Activities, Training/Technical Assistance, and Research	+	-	+	+	+
E	No pest management program	0	0	0	0	0

Impact Rating System

++++ Major beneficial impact
+++ Moderate beneficial impact
++ Minor beneficial impact
+ Slight beneficial impact
0 No identifiable impact
- Slight adverse impact
-- Minor adverse impact
--- Moderate adverse impact
---- Major adverse impact

a/ Pesticide activity is defined to include all activities conducted, supported, financed, or otherwise assisted by AID for the procurement or use of pesticides, but does not include pesticide research and pesticide regulatory activities.

b/ AID Regulations (AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975, except that the use of the historical commodity eligibility list for pesticides would not apply), Regulation No. 16 (Federal Register, 41(127):26913-26919, June 30, 1976), plus "risk-benefit" analysis of each pesticide activity.

c/ AID Regulations (AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975, except that the use of the historical commodity eligibility list for pesticides would not apply), Regulation No. 16 (Federal Register, 41(127):26913-26919, June 30, 1976), plus the restrictions of the Stipulation and Court Order of December 5, 1975.

Table 57: Comparison of Impacts of Alternative Pest Management Programs for Food Production and Preservation on the United States and Extraterritorial Global Areas

Alternative	Program Elements	General Impact Areas: Human Health	Environment	Economics	Agriculture	Social
A	Pesticide Activities[a/] Other Pest Management Activities, Training/Technical Assistance, and Research as described for the currently identified AID Pest Management Program (see Chapter II)	+	-	+	++	+
B	"Modified" Pesticide Activities;[b/] with full Other Pest Management Activities, Training/Technical Assistance, and Research	+	0	+	++	+
C	"Restricted" Pesticide Activities;[c/] with full Other Pest Management Activities, Training/Technical Assistance; and Research	+	0	0	+	0
D	No Pesticide Activities; with full Other Pest Management Activities, Training/Technical Assistance, and Research	0	0	0	0	0
E	No pest management program	0	0	0	0	0

Impact Rating System

++++ Major beneficial impact
+++ Moderate beneficial impact
++ Minor beneficial impact
+ Slight beneficial impact
0 No identifiable impact
- Slight adverse impact
-- Minor adverse impact
--- Moderate adverse impact
---- Major adverse impact

a/ Pesticide Activity is defined to include all activities conducted, supported, financed, or otherwise assisted by AID for the procurement or use of pesticides, but does not include pesticide research and pesticide regulatory activities.

b/ AID Regulations (AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975, except that the use of the historical commodity eligibility list for pesticides would not apply), Regulation No. 16 (Federal Register, 41(127):26913-26919, June 30, 1976), plus "risk-benefit" analysis of each pesticide activity.

c/ AID Regulations (AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975, except that the use of the historical commodity eligibility list for pesticides would not apply), Regulation No. 16 (Federal Register, 41(127):26913-26919, June 30, 1976), plus the restrictions of the Stipulation and Court Order of December 5, 1975.

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CHAPTER V

FUTURE PEST MANAGEMENT PROGRAM EVALUATION

INTRODUCTION

The Agency for International Development will continue to conduct a broad range of activities addressing such basic problems as hunger and malnutrition, overpopulation, disease, disaster, illiteracy, and lack of adequate housing and transportation. Many of these activities potentially require the control of pests to meet the stated goals. For purposes of analysis, the pest management aspects of AID's future activities have been collectively termed AID's pest management "program," and have been categorized into two program areas: (a) public health and (b) food production and preservation. (Conceptually, a third program area exists for pest management activities addressed to other areas, such as nonfood crop production. However, there is no activity in this "other programs" area currently identified for the AID Pest Management Program, i.e., through CY 1978.) Each of the program areas potentially involves four program elements: (a) pesticide activities, (b) training and technical assistance, (c) research, and (d) other pest management activities.

An important part of this study was the development of analytical methodologies which will allow AID to identify the overall "best" programs for its future pest management activities. A best program should be one which embodies a combination of program elements selected to meet identified critical needs of the recipient country for pest management activities, promotes overall environmental quality in the long term while minimizing environmental impacts in reaching short-term goals, and provides AID with flexibility in determining its future pest management program.

A number of approaches to the development of this methodology were considered. The first approach considered uses numerical taxonomy as the basis for analyzing each country (1). This approach has been used before to determine the degree of development and modernization within many of the countries under consideration for assistance (2). However, the limitations imposed on the development of this EIS did not permit the use of this complex type of analysis.

The second approach considered was an ecological/economic approach (3,4,5). This field of research, however, is too new and few studies relative to this problem exist at this time.

The technique used combined parts of these two approaches with yet another approach which was termed "basic needs indicators" (3,6,7,8,9). Traditional indicators such as GNP and caloric intake and new variables such as sanitation level and level of technology were examined for their suitability in devising a scheme whereby each country could be analyzed in terms of those variables which reflect "basic needs" or "quality of life." This approach did allow for differences between countries as well as differences within countries. The mix of indicators sought was sufficiently broad so as to address the needs of a wide variety of individual countries in a wide variety of climates and with widely varying ecosystems.

The use of this approach required the development of three methodologies. One methodology was needed to group or aggregate potential recipient countries by relative degree of development. Another methodology addressed the overall consequences of various program alternatives. The findings of this latter methodology were used in a third methodology to determine the "best" overall pest management program.

PROBLEM AREAS

There are four major problems areas to be addressed in the development of these methodologies:

1. Quantitative imprecision,
2. Appropriate aggregation levels for project specific impact analysis,
3. Appropriate aggregation levels for program/area analysis, and
4. Appropriate aggregation levels for decision making.

Quantitative Imprecision

A rigorous, quantitative analysis is not possible because of the limitations in available data. In particular, pesticide use information on planned programs and projects is limited and information on the potential impacts so generalized that it is of limited value for analytical purposes. More to the point of this analysis, in a programmatic perspective, specific impacts are not evaluated in favor of aggregate measures of impact to allow for maximum flexibility in program area development while minimizing the adverse environmental impacts on host countries, the United States, and extraterritorial global area.

Appropriate Aggregation Levels for Project-Specific Impacts

Individual analysis of each project is neither appropriate nor feasible for programmatic assessment. There are too many projects and limited country-specific data to treat individual countries as specific cases where a hazard or benefit may occur. As a consequence, in order to prepare a programmatic environmental impact statement, aggregation of project-specific impacts is necessary.

Aggregation of Impacts for Program Area Analysis

This step draws the distinction between specific project analysis and program area analysis of impacts. A number of parameters have been defined and then used to determine the impact of a suggested alternative for a given program area (e.g., public health). These parameters have been derived from the data available on less developed countries where AID has supported or anticipates supporting pest management activity.

Aggregation of Impacts for Decision Making

The same format suggested for program area analysis will also fit here. The aggregations developed for program area analysis can be used by decision-makers in the determination of the optimal mix of program areas that can be used to meet the needs of the country requesting AID's assistance, no matter what the country's needs may be.

METHODOLOGY FOR THE DEVELOPMENT OF AGGREGATION LEVELS

Because country-specific analyses were not feasible, a system to develop appropriate aggregation levels for countries under consideration for assistance from AID was needed. A uniform system of aggregation, based on relative weights assigned to pertinent factors, was prepared (see Table 58). Within this system, factors were split into subfactors. These subfactors were then assigned parameters and parameter ranges each with a specific relative weight. By examining a country's characteristics a score could be developed for the country. On the basis of the range of scores that occurred for the countries under consideration, countries can be aggregated for analyzing the effects that proposed activities would have, and for determining the "best" program for pest management.

A system such as the one used is limited by the lack of data on the specific countries under consideration. This lack of a well-developed data base required that a number of assumptions be made about the relationship between parameters and factors used, and the impact of assistance on less developed countries. Clearly, the lack of a strong data base influences the degree to which one can be assured that a given event has a given consequence, causing a specific impact. This problem was minimized, however, by using the basic needs indicators approach. To the extent that basic needs are met, a quality of life in that country exists.

Table 58: Methodology for Development of Aggregation Levels.

Factor	Factor Weight	Subfactor	Subfactor Weight	Parameters	Parameter Subranges	Evaluation Points
Human Health	30					
		Disease and Occupational Health	10	% of Total Population Affected	< 10	0
					10-20	2
					20-30	4
					30-40	6
					40-50	8
					> 50	10
		Nutrition	10	Daily Per Capita Caloric Intake	> 3,000	0
					2,700-3,000	1
					2,400-2,700	3
					2,100-2,400	5
					1,800-2,100	7
					1,500-1,800	9
					< 1,500	10
		Population Growth Rate	3	%/Year	< 1	0
					1-2	1
					2-3	2
					3-4	3
		Life Expectancy	2	Years	> 50	0
					40-50	1
					< 40	2
		Infant Mortality	2	Deaths/1,000 Live Births	< 50	0
					50-100	1
					> 100	2
		Sanitation	2	a/	Good	0
					Adequate	1
					Poor	2
		Medical Capabilities	1	a/	Adequate	0
					Poor	1
Environment	25					
		Water Quality and Quantity	8	a/	Good	3
					Adequate	5
					Poor	8
		Fish and Wildlife	7	No. of Endangered Species	< 5	0
					5-10	1
					10-15	3
					15-20	5
					> 20	7
		Land Use	6	% of Undisturbed Land	< 30	0
					30-40	1
					40-50	2
					50-60	3
					60-70	4
					70-80	5
					> 80	6
		Forest	4	% of Land as Forest	< 10	0
					10-20	1
					20-30	2
					30-40	3
					> 40	4

Table 58 (Concluded): Methodology for Development of Aggregation Levels

Factor	Factor Weight	Subfactor	Subfactor Weight	Parameters	Parameter Subranges	Evaluation Points
Economics	25					
		Per Capita GNP	10	U.S. Dollars	> 1,100	1
					900-1,100	2
					700-900	3
					500-700	4
					400-500	5
					300-400	6
					200-300	7
					150-200	8
					100-150	9
					< 100	10
		Nonagricultural Employment	10	%	> 60	1
					50-60	2
					40-50	4
					30-40	6
					20-30	8
					10-20	9
					< 10	10
		Industrial Level	5	% of Total Economy	> 50 Developed	1
					20-50 Less Developed	3
					< 20 Developing	5
Agriculture	15					
		Agricultural Self-Sufficiency	4	a/	Good	0
					Adequate	1
					Mediocre	3
					Poor	4
		Level of Technology	4	-	Mechanized	0
					Semimechanized	1
					Animal	2
					Manual	4
		Estimated Potential Crop Loss from Pests	4	%	< 10	0
					10-25	1
					25-35	2
					35-50	3
					> 50	4
		Agricultural Potential	1	a/	Good	0
					Poor	1
		Crops for Export	1	-	Yes	0
					No	1
		Income from Exports	1	-	Excess Balance of Trade	0
					Deficit Balance of Trade	1
Social Organization	5					
		Social Development	2.5	a/	Highly Developed	0.0
					Developed	0.5
					Less Developed	1.5
					Developing	2.5
		Literacy Rate	1.5	%	> 50	0.0
					30-50	0.5
					20-30	1.0
					< 20	1.5
		Cultural Life	0.5	a/	Strong	0.5
					Weak	0.0
		Family Life	0.5	a/	Strong	0.5
					Weak	0.0

a/ Subjective evaluation.

The ideal analysis would consider each country individually as suggested by the methodology. But for this study that approach was impossible. Not only would the result be quite lengthy, but also it would not lend itself to a programmatic analysis. Because of this problem, aggregate "pictures" of the characteristics of recipient countries were developed. This methodology provides a means to determine a given country's aggregate position, and in turn this aggregate position will indicate the general type of program for which the country should be considered.

Specific Assumptions

A number of assumptions were made to determine the relative importance (weights) of factors and subfactors. These assumptions have been made from the perspective of what is considered to be the idealistic order of concern for the overall development within the LDC's, a perspective not necessarily shared by all LDC's themselves. With the assistance of the Department of State Committee on Internationl Environmental Affairs (CIEA), the weights were assigned to the factors and subfactors, based on their relative importance in determining the impact of proposed activities.

Explicit assumptions made in the development of these weights were:

1. Economic self-sufficiency is the goal of all LDC's;

2. Human health is the most important problem;

3. Environmental quality is an important factor in economic development;

4. Economic development is a function of political development; and

5. Technical decisions are dependent on political decisions.

Factors

The following factors were used in this analysis: human health, environment, economics, agriculture, and social organization (see Table 58). These factors form the basis for all EIS analyses and serve as the starting point for this analysis.

Using a scale of 100 weight points and the stated assumptions, weight allocations were assigned to the five factors. On the basis of this system, the weights for each factor are:

Human Health	30
Environment	25
Economics	25
Agriculture	15
Social Organization	5

Subfactors

The factors under consideration needed to be broken down into component subfactors of interest. Numerous potential subfactors were identified; those most relevant to this aggregation effort were then selected. Subfactor weight allocations were made for each subfactor as shown in Table 58.

Subfactor Parameters

Each subfactor was given a parameter (dimension or unit) with a range and a subrange of possible values. Evaluation points were then assigned to each subrange under the subfactor parameter. In this scheme, "poor" countries would receive a high point value and more developed countries would receive a low point value (see Table 58). Although exact evaluation points are assigned, it should be remembered that these points are relative in nature and are based on a collective judgment.

Most of the parameters are based on precise data; others are judgmental in nature. The greater the importance of the subfactor, the greater the reliance on existing data, rather than on judgments.

One problem encountered was the development of the ranges and subranges for the parameters. Table 59 illustrates the range of values for example parameters by geographical area. However, because the ranges were found to be fairly substantial, this problem has been minimized.

Within this analysis it is not valid to compare weights within factor areas or between factor areas. It is not valid to say, for example, that a subfactor weight of "10" in the human health area is equivalent to a subfactor weight of "10" in the economic area. Nor is it valid to say that an evaluation point of "10" in the percentage of total population debilitated by disease is 10 times as important as an evaluation point of "1" in medical capabilities. It is suggested that within the framework of analysis established, some subfactors are more important than others but in no case can these points be construed as precisely defining subfactor differences.

Table 59: Example Parameter Ranges by Geographical Areas[a]

Parameters	Latin America (18 Countries)	Near East (4 Countries)	Middle East (5 Countries)	Africa (9 Countries)	Asia (8 Countries)	Total Range
Per Capita GNP (1973 $'s)	230-940	90-410	250-370 (Israel-2,790)	70-330	70-270	70-2,790
Population Growth Rate Rate (%)	1.1-3.5	2.5-3.0	-0.4-3.6	2.4-3.3	2.1-2.9	-0.4-3.6
Life Expectancy (Years)	45-69	40-45	52-72	38-49	44-69	38-72
Infant Mortality (Deaths per 1,000 live births)	26-149	130-175	22-100	119-170	46-152	22-175
Labor Force Engaged in Agriculture (%)	21-77	46-82	7-54	55-91	41-80	7-91
Literacy Rate (%)	10-90	8-32	32-88	5-25	12-84	5-90

Source: Midwest Research Institute, Country Profiles, a report for the Agency for International Development, September 1976, Contract No. AID/ta-C-1302.

a/ Compare with F. Hartison, Quantitative Analysis of Modernization and Development, Princeton University Press (1970), pp. 20-28 (Ref. 2); or with G. Jones, The Role of Science and Technology in Developing Countries, Oxford University Press, London (1971), p. 3 (Ref. 10).

Aggregation Levels

The specific methodology required that some of the countries under consideration be analyzed as representative examples of all recipient countries, in order to categorize these countries into aggregates. Sample countries were rated on a scale of 0 to 100 in terms of their development; the higher the score, the lower the degree of present development.

On the basis of this analysis, three levels of aggregation clearly emerged. Aggregate I countries are those most in need of foreign assistance. Aggregate II countries show a substantial need for foreign assistance to maintain their current level of progress. Aggregate III countries show some need for foreign assistance, but have also developed themselves to such a level that in certain areas they are capable of meeting their own needs.

Using the subfactor parameters (Table 58) a country with a rating greater than 60 is an Aggregate I country; that is, it is most in need of foreign assistance. Those countries with a rating of 41 to 60 are Aggregate II countries, indicating a need for substantial foreign assistance. Any country with a rating of 40 or less could be considered an Aggregate III country, indicating a probable need for some but not extensive foreign assistance. A general description of each aggregate is given in Table 60.

It should be emphasized that these are general descriptions of the aggregation levels. A particular country may have a rating similar to one level of aggregation in one factor area and a rating similar to a different aggregation level in another factor area.

METHODOLOGY TO DETERMINE THE IMPACT OF ALTERNATIVES

Given analytical factors and aggregation levels, it was necessary to determine the magnitude of impact in a given program area using the alternatives developed in Chapter III.

This analysis addressed each of the alternative-program area-aggregation combinations. (All 45 potential combinations are shown in Figure 11. For example, the shaded area represents the consequences of applying Alternative A to the food production and preservation activities in the Aggregate III LDC's.) By holding the program area and the aggregation level constant and by using the analytical factors of the previous methodology, the impacts of various alternatives can be determined. For areas where specific AID activities are planned, this required 30 such analyses. (No pest management program activities are planned for the "other programs area" shown in Figure 11.)

Table 60: General Description of Aggregates by Level

Aggregate I Countries

Human Health - 30	
Disease/Occupational Health	A large percentage of the population (> 40%) are ill and have difficulty working
Nutrition	Insufficient nutritional levels
Population Growth Rate	High rates of population growth
Life Expectancy	Short life expectancies
Infant Mortality	High infant mortality rates
Sanitation	Poor sanitation
Medical Facilities	Poor medical facilities
Environment - 25	
Water Quality and Quantity	Relatively poor water quality and quantity
Fish and Wildlife	Abundant habitat of adequate quality
Land Use	Little land in productive cultivation
Forest	Large percentage of land as forest
Economics - 25	
Per Capita GNP	Low per capita GNP
Nonagricultural Employment	Low employment levels outside agriculture
Industry Level	Just beginning to develop industry
Agriculture - 15	
Agricultural Self-Sufficiency	Poor
Level of Technology	Manual or animal technical level
Estimated Potential Crop Lost from Pests	High crop destruction
Agricultural Potential	Poor agricultural potential
Crops for Export	Few crops for export
Income from Exports	Little income from crop export
Social Organization - 5	
Social Development	Just at the beginning of development
Literacy Rate	Low rate of literacy
Cultural Life	Maintains strong, traditional cultural roots
Family Life	Exhibits strong traditional familial ties

Table 60 (Continued): General Description of Aggregates by Level

Aggregate II Countries	
Human Health - 30	
Disease/Occupational Health	A fair percentage of the population are ill (20-40%) and have difficulty working
Nutrition	Barely adequate nutritional levels
Population Growth Rate	Moderate population growth rates
Life Expectancy	Moderate life expectancies
Infant Mortality	Moderate to high infant mortality rates
Sanitation	Generally poor
Medical Facilities	Generally poor
Environment - 25	
Water Quality and Quantity	Poor to adequate water quality and quantity
Fish and Wildlife	Moderate amounts of habitat of fair quality
Land Use	Some land in productive use
Forest	Moderate percentage of land as forest
Economics - 25	
Per Capita GNP	Moderate per capita GNP
Nonagricultural Employment	Relatively low employment levels outside agriculture
Industry Level	Some development/progress
Agriculture - 15	
Agricultural Self-Sufficiency	Poor or mediocre agricultural self-sufficiency
Level of Technology	Minimal - some semimechanized farming
Estimated Potential Crop Loss from Pests	Moderate crop losses
Agricultural Potential	Some agricultural potential
Crops for Export	Some crops for export
Income from Export	Some income from crop exports
Social Organization - 5	
Social Development	Moderate development
Literacy Rate	Low to moderate literacy rate
Cultural Life	Maintains moderate traditional cultural roo
Family Life	Exhibits moderate traditional familial ties

Table 60 (Concluded): General Description of Aggregates by Level

Aggregate III Countries	
Human Health - 30	
Disease/Occupational Health	A low percentage of the population (< 20%) are ill and have difficulty working
Nutrition	Sufficient nutritional levels
Population Growth Rate	Low to moderate population growth rates
Life Expectancy	Moderate to high life expectancies
Infant Mortality	Low to moderate infant mortality
Sanitation	Adequate to good sanitation
Medical Facilities	Adequate medical facilities
Environment - 25	
Water Quality and Quantity	Adequate to good water quality and quantity
Fish and Wildlife	Small amounts of habitat of fair to poor quality
Land Use	Moderate to high amounts of land in cultivation
Forest	Moderate to low percentage of land as forest
Economics - 25	
Per Capita GNP	Moderate to high per capita GNP
Nonagricultural Employment	Moderate to high level of nonagricultural employment
Industry Level	Moderate to substantial industrial development
Agriculture - 15	
Agricultural Self-Sufficiency	Adequate to good level of self-sufficiency
Level of Technology	Semi-mechanized to mechanized level of technology
Estimated Potential Crop Loss from Pests	Low estimates of crop losses
Agricultural Potential	Good potential
Crops for Export	Crops for export
Income from Exports	Income from crop exports
Social Organization - 5	
Social Development	Developed or highly developed
Literacy Rate	High literacy rates
Cultural Life	Cultural roots may be weakened by industrialization/urbanization
Family Life	Strength of familial ties may be weakened by industrialization/urbanization

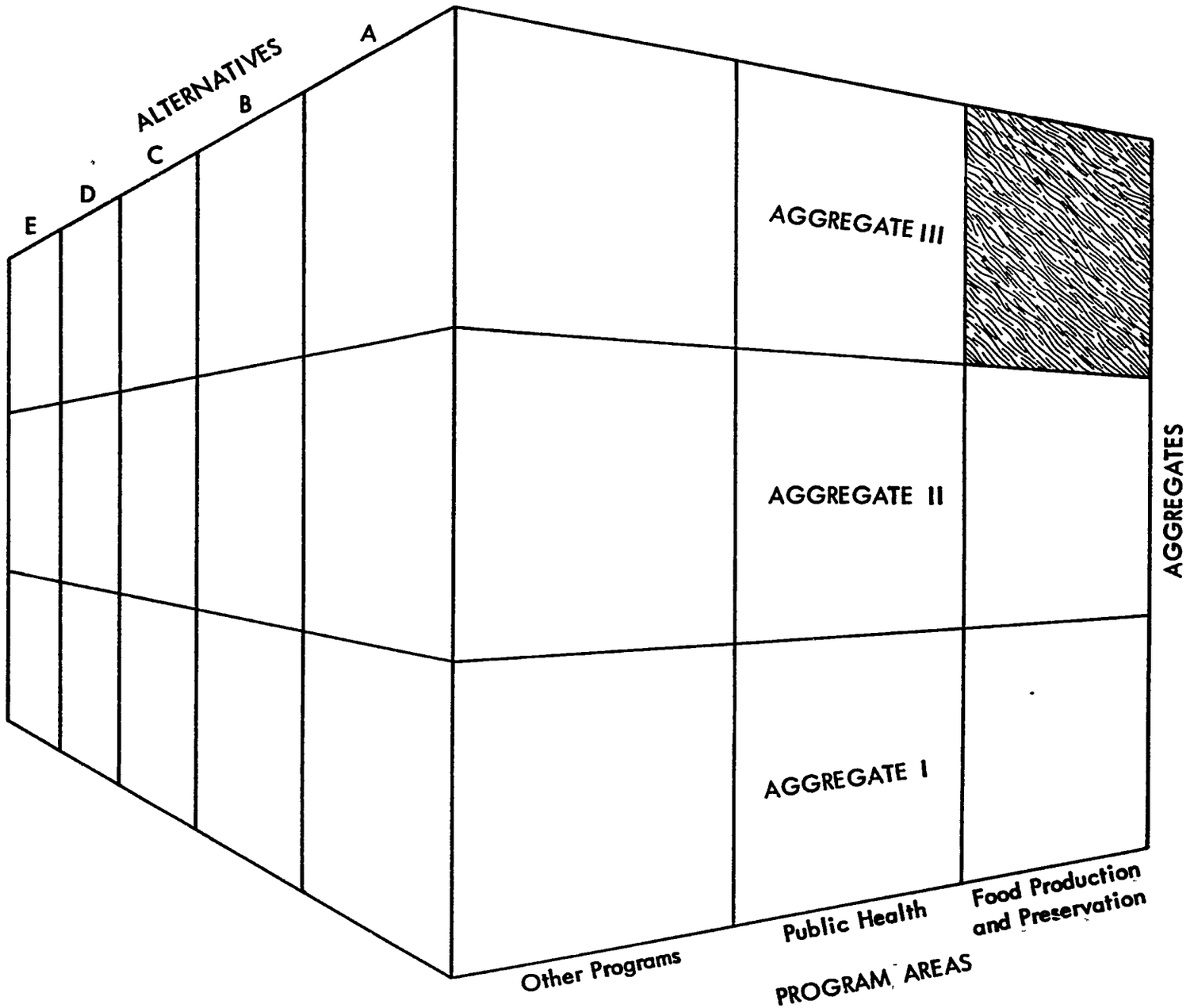

Figure 11 - Possible Subject Areas for Analysis

To complete these analyses, professional judgments were made on the magnitude and direction of impact by aggregation level and alternative. Multiplying the magnitude of impact on a given subfactor by the weight of that subfactor gives a plus or minus value. These values, for each factor area, were summed algebraically to determine the overall raw score for a given interaction. This raw score is a weighted indication of the impact of a proposed alternative in a given program area by level of aggregation (see Figure 12, A).

Repeating this process for each aggregate, alternative, and program area completes a matrix similar to that shown in Figure 12, B.

METHODOLOGY TO DETERMINE THE BEST PEST MANAGEMENT ALTERNATIVE BY AGGREGATE LEVEL

Given the degree of impact, it remained to determine the best alternatives(s) by aggregation level. In keeping with the numbers generated by the previous methodologies, the highest positive value among the alternatives represents the best alternative for the program area and aggregation level (see Figure 12, C).

DETERMINATION OF EFFECTS BY AGGREGATION, ALTERNATIVE, AND PROGRAM AREA

Having devised a methodology to determine the effects* of proposed alternatives to AID's current activities, this methodology was used to calculate the effect of proposed alternatives on aggregation levels by program area. Magnitudes of the potential effect ranged from +++ to --- with no zero value.** Subfactor indicator values remained the same for this analysis. As in Chapter IV, professional judgment was used to determine magnitude of effect.

Table 61 shows the resultant raw scores for each calculation. (Normalized scores*** included in the table are subsequently used to determine the "best" program.)

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* The effects referred to are the overall effect that proposed alternatives would have on respective subfactor areas for each country, not the environmental impact of the proposed alternatives. The types of potential changes that would occur within a less developed country resulting from alternative programs, are discussed and compared to the planned program (Alternative A).

** All activities have some effect on each of the subfactors even though the effect may be only slightly positive or negative. While environmental impacts may suggest that no known or observable effects occur, in the overall analysis of impact this will not be the case.

*** Raw scores are normalized by taking a base case score (in this analysis, Alternative A) and making it equal to zero. The base case raw score is then subtracted from the raw score of the alternatives to obtain the normalized score for the alternatives.

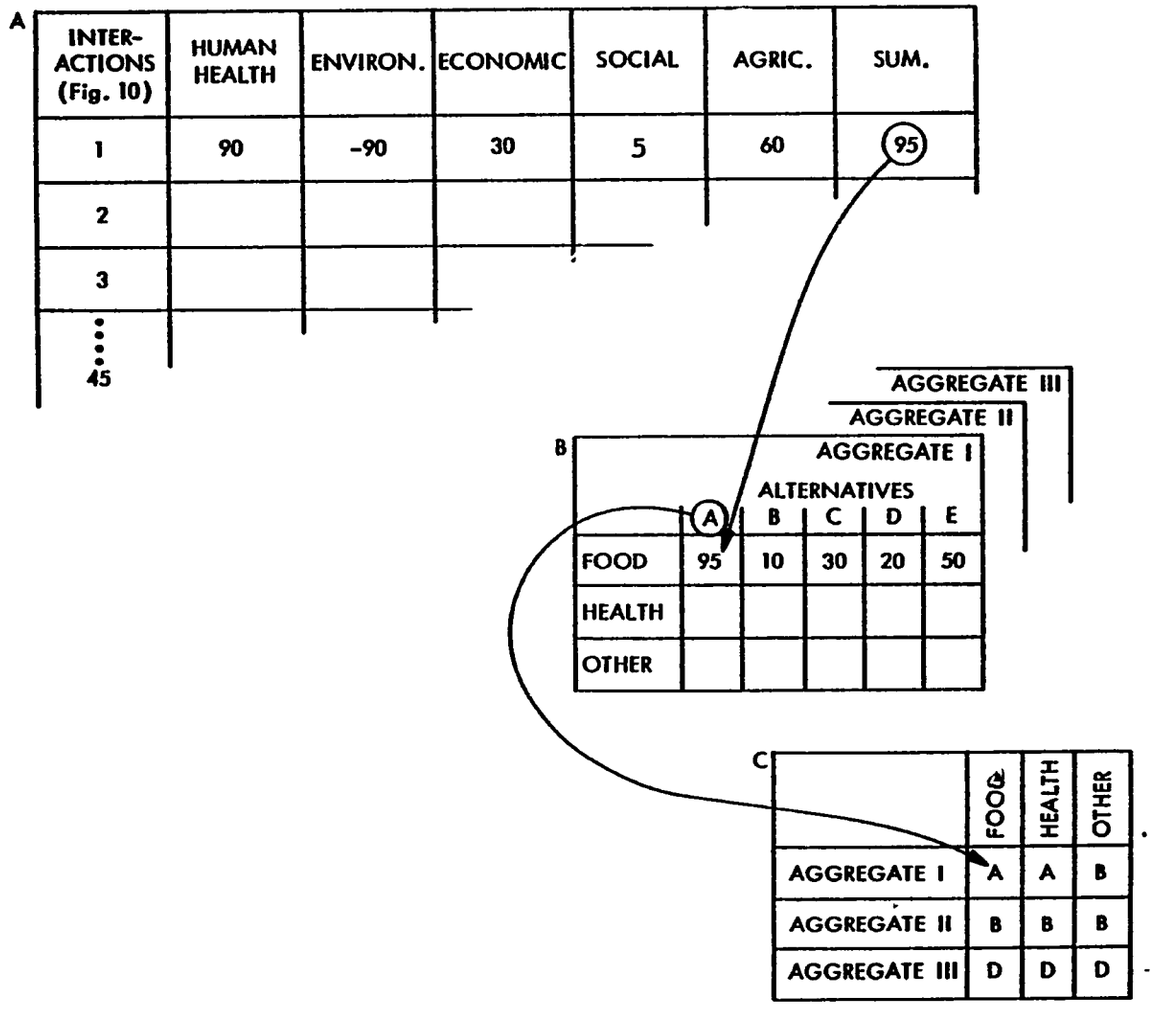

Figure 12 - Example Analysis

Table 61: Summary of Overall Impact Calculations by Aggregate, Alternative, and Program Area

	Food Production		Human Health	
	Raw Score	Normalized Score	Raw Score	Normalized Score
Aggregate I				
Alternative A	69	0	112	0 a/
Alternative B	84	+15	106	-6
Alternative C	57	-12	112	0 a/
Alternative D	63	-6	93	-19
Alternative E	-61.5	-130.5	-84	-196
Aggregate II				
Alternative A	38	0	64	0 a/
Alternative B	59	+21	84	+20
Alternative C	23	-15	64	0 a/
Alternative D	44	+6	16	-48
Alternative E	-28.5	-66	-19	-83
Aggregate III				
Alternative A	50	0 b/	No Planned AID Programs	
Alternative B	50	0 b/		
Alternative C	50	0 b/		
Alternative D	80	+30		
Alternative E	12	-57		

a/ By definition, in the health area, Alternatives A and C are identical; therefore, they are equivalent in terms of effect.

b/ There were no differences between Alternatives A, B, and C in terms of effect.

Within Aggregate I countries, three health and at least two of the food alternatives appear to be likely candidates for the pest management assistance program which would best meet immediate needs while preserving long-term environmental quality. Among the alternatives for Aggregate II countries, three food and three health alternatives represented candidates for the most appropriate program. In Aggregate III countries, health program alternatives were not considered because there were no current or planned AID health programs in Aggregate III countries. Four alternatives in the food area were prospects for the most appropriate (best) pest management program in Aggregate III countries.

DETERMINATION OF THE BEST OVERALL PEST MANAGEMENT PROGRAMS

It remains now to select the best pest management program from the options suggested by the impact analysis, based on the normalized score. The alternative within each program area and aggregate having the highest positive score represents the best alternative to follow for that particular program area and aggregation level; that is, these alternatives will have the greatest overall positive effect on the countries in the various aggregates.

Table 62 details the best pest management program by program area and aggregation level. For Aggregate I countries, in the food production area, Alternative B with a normalized score of +15 exceeds the normalized score of Alternative A, the base case for this analysis. In the health area for Aggregate I countries, either Alternatives A or C could be used for pest management as both alternatives have a zero score and all other alternatives have negative normalized scores.

When considering Aggregate II countries, in terms of food production, Alternative B represents the best alternative because its +21 normalized score is higher than both Alternative D and the base case. The analyses in the health area for Aggregate II countries clearly show that Alternative B is again favored as the best pest management program in the health area.

In Aggregate III countries, impacts of pesticide activity in the health area are not evaluated because there are no current or anticipated health programs planned for this aggregate. In the food production area of Aggregate III countries, Alternative D emerges as the preferred alternative.

In summation, food production for Aggregate I countries will require modified pesticide activities with a full complement of technical training, technical assistance, and research activities. Health concerns in Aggregate I countries dictate complete pesticide activities plus technical training, assistance, and research. Aggregate II countries for food production will require modified pesticide activities coupled with extensive technical training, assistance, and research. The area of human health needs for

Table 62: Best Pest Management Program by Aggregate and Program Area

	Best Pest Management Alternative	Program Elements	Regulatory Restrictions
PUBLIC HEALTH			
Aggregate I	A	Pesticide Activities[a] Training/Technical Assistance, Research and Other Pest Management Activities, as described for the currently identified AID Pest Management Program (see Chapter II)	AID Regulations[b] Plus AID Environmental Procedures (Regulation No. 16)[c]
Aggregate II	B	"Modified" Pesticide Activities; with full Training/Technical Assistance, Research, and Other Pest Management Activities	AID Regulations,[d] Regulation No. 16,[c] plus "risk-benefit" analysis of each pesticide activity
Aggregate III	-	Not Determined	-
FOOD PRODUCTION AND PRESERVATION			
Aggregate I	B	"Modified" Pesticide Activities; with full Training/Technical Assistance, Research, and Other Pest Management Activities	AID Regulations,[d] Regulation No. 16,[c] plus "risk-benefit" analysis of each pesticide activity
Aggregate II	B	"Modified" Pesticide Activities; with full Training/Technical Assistance, Research, and Other Pest Management Activities	AID Regulations,[d] Regulation No. 16,[c] plus "risk-benefit" analysis of each pesticide activity
Aggregate III	D	No pesticide activities; with full Training/Technical Assistance, Research, and Other Pest Management Activities	Regulation No. 16[c]

a/ Pesticide activity is defined as the procurement and use of pesticide active ingredient, but does not include pesticide research and pesticide regulatory activities.

b/ AID regulations and methods for pesticide procurement and use as they existed immediately prior to the Stipulation and Court Order of December 5, 1975.

c/ Federal Register, 41(127):26913-26919, June 30, 1976.

d/ The same regulatory restrictions set forth in Footnote b, except that use of the historical commodity eligibility list for pesticides would not apply.

Aggregate II countries will require the same types of activity as required for food production. In terms of food production for Aggregate III countries, no pesticide activities, but technical training, assistance, and research represent the best pest management program to meet the needs of the countries. It should also be noted that in terms of the analysis Alternative E, no AID Pest Management Program, represented the worst alternative for all program areas and aggregation levels evaluated.

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CHAPTER VI

AID'S FUTURE PEST MANAGEMENT POLICIES AND STRATEGIES

INTRODUCTION

In Chapter III, five alternatives for the AID pest management program were identified and described. In Chapter IV, the environmental impacts of each of these alternatives on AID's pest management programs in the areas of public health and food production and preservation were evaluated. In Chapter V, a methodology was developed for determining the best overall program for AID's future pest management activities in public health and for food production and preservation for three different country aggregations.

One of the pest management program alternatives discussed in these chapters is "no pest management program" (Alternative E). In the remaining four alternatives, only one of the four major pest management program elements (pesticide activities; training and technical assistance; research; and other pest management activities) is varied, i.e., the element "pesticide activities" from a "full program" (Alternative A) to "no pesticide activities" (Alternative D). Alternatives B and C provide for intermediate levels of pesticide activities.

Major emphasis was placed on pesticide activities because among the four pest management program elements, pesticide activities have the greatest potential for causing direct environmental effects. Compared to other types of development assistance and agricultural production inputs, pesticides have a disproportionately large leverage effect; they can produce great benefits when used properly, or great harm when used improperly.

The information presented and the evaluations performed in Chapters III to V led to the conclusion that for most countries and program areas, Alternative B will be the most appropriate program.

This chapter describes a number of factors that influence the overall effectiveness and consequences of AID's pest management activities and sets forth the Agency's future pest management policies and strategies, and plans for their implementation.

FACTORS AFFECTING AID'S PEST MANAGEMENT ACTIVITIES

The factors analyzed in this section which affect AID's pest management activities in less developed countries are based on the following information sources:

* Data and findings presented in the preceding chapters of this document and in the appendices.

* Comments from 30 scientists participating in the UC/AID pest management project which recently surveyed crop protection and pesticide problems in less developed countries (see page 339).

* The results of an international survey on pesticide use conducted by the UC/AID Panel on Pesticides in 1972 (1). In this survey, a set of nine questions was sent to 54 organizations and individuals worldwide to solicit their opinions on pesticide problems in less developed countries. Twenty-one responses (about 40%) were received. Geographic representation of the respondents included India, Sri Lanka, Thailand, Malaysia, the Philippines, Hong Kong, Colombia, Venezuela, Costa Rica, and Nigeria (see page 67).

* A special report entitled "An Evaluation of the Realistic Requirements of Tropical Countries for Pesticides" prepared by Dr. R. deB. Ashworth (2), supplemented by personal communications (3). Dr. Ashworth is an internationally known and recognized expert on worldwide pesticide uses and problems. Previously with the British Ministry of Agriculture, Fisheries and Food, he recently served as an FAO consultant on pesticides to the Government of Malaysia. For many years, Dr. Ashworth served as chairman of the FAO Working Party of Experts on the Official Control of Pesticides and as chairman of CIPAC, the Collaborative International Pesticides Analytical Council, Ltd.

* Information obtained during the development of this document by personal interviews with international and United States agencies and organizations concerned with pest management, pesticides, crop protection, vector control, and related environmental problems. Agencies and organizations interviewed personally between April and July 1976 include the Food and Agriculture Organization of the United Nations, Rome, Italy; the World Health Organization, Geneva, Switzerland; the U.S. Environmental Protection Agency; U.S. Department of the Interior, Fish and Wildlife Service; the Council on Environmental Quality; the U.S. Department of Agriculture; and the U.S. Department of Health, Education, and Welfare, Public Health Service.

* The publications cited within the text of this chapter.

* Information supplied by the various reviewers of the draft EIS (see Appendix H, Volume II).

Limited AID Influence

It must be recognized that less developed countries receiving AID pest management assistance are independent, sovereign states with their own individual national policies, needs, priorities, and perceptions of the relative importance of environmental quality versus economic development. AID's influence on the development strategies and priorities of recipient less developed countries has finite limitations. These countries cannot be expected invariably to accept U.S. environmental concepts or pesticide policies when they conflict with their own national policies and priorities.

Thus, many of the conditions and problems discussed in this section, especially those discussed under "pesticide problems," are beyond AID's direct control or influence and can only be solved by the countries themselves. However, as set forth in the subsequent sections, AID will, in its future programs, increase its efforts to assist less developed countries in improving their capabilities for sound management of their pest and pesticide problems.

Increasing Pesticide Demand in Less Developed Countries

Losses due to pests (insects, diseases, and weeds) in South America, Africa, and Asia were recently estimated at 33.0, 41.6, and 43.3%, respectively, of the potential crop production (by value) in these areas (4). Worldwide losses of food to pests (insects, pathogens, weeds, mammals, and birds) are estimated to be about 48% in spite of all pest controls now employed (5). Of this, preharvest losses account for about 35%, and postharvest losses are about 20% of the actual harvest.

Less developed countries encompass about 60% of the world's arable land, with a very high potential level of agricultural production. However, current yields per unit of land area are less than half those of Europe and the United States, and only about a quarter of those achieved in Japan. According to FAO statistics, crop productivity and the use of pesticides appear to be positively correlated. Perfect's (6) calculations, based on FAO data, indicate that for crop yields in Latin America, Africa, and India to rise fivefold (putting them on a par with yields in Japan), pesticide use would need to be increased some 70- to 85-fold. For the planned doubling of crop production in a 30-year period, pesticide inputs will have to be increased fivefold, i.e., from the 120,000 MT used in 1963 to 600,000 MT/year in 1993, according to Perfect (6). Other means of pest management will increase in scope and importance, but even so, it is likely that there will be large increases in pesticide use in less developed countries in the near future, sponsored by the governments of these countries (6,7).

As documented in Chapter I, AID-financed pesticides represent only a small share (about 1.6% by value in 1974) of the pesticides used in less developed countries (not including centrally planned economies). Thus, the projected volume of AID pesticide activities will not significantly affect the total volume of use of pesticides in these countries. However, AID-supported pest management activities present the Agency and thus the United States with opportunities for influencing the quality of pest management practices in less developed countries.

Need for Integrated Pest Management

Recent experience in many developed as well as less developed countries indicates that in combating pests, reliance on chemical pesticides exclusively will result in additional problems: for example, the development of pest populations resistant to pesticides; increasingly rapid resurgence of target pest populations following treatment; outbreaks of secondary pests which did not cause economic damage previously; destruction of beneficial insect predators, parasites, and pollinators; and adverse effects on wildlife. Where persistent pesticides were used, undesirable residues may occur in treated crops or livestock, in humans, and in water, soil, air, and nontarget biota.

The best strategy for controlling most pests is the coordinated use of all available control tools, including chemical pesticides, in the context of integrated pest management-crop production systems, as documented convincingly by a number of different studies and authors, including the Council on Environmental Quality (8), Smith (9), Apple (10), Glass (11), Ennis et al. (12), and Pimentel (5). However, many less developed countries currently do not have the expertise, trained personnel, and other resources required for the establishment and implementation of ecologically and economically sound integrated pest management systems.

Need for Pesticide Management

To varying degrees, most or all less developed countries currently lack the infrastructures (expertise, qualified personnel, legal framework, funding, facilities, and other resources) necessary for the effective regulation, control, handling, and distribution of pesticides, and for providing for their safe and productive use. International organizations including FAO and WHO have developed a model pesticide licensing and approval scheme, model labeling guidance on efficiency and safety in transport and use of pesticides, quality and performance specifications for pesticides for crop protection and public health purposes, methods for monitoring these properties, and recommended international tolerances for pesticide residues (13,14).

However, establishment and implementation of these systems has been slow. Reasons for the lack of more rapid progress in the implementation of international pesticide standards include the low level of support on the part of many developed countries (15).

The need for integrated pest management systems and the need for pesticide management infrastructures in less developed countries are closely related. The "agromedical* approach" is designed to assist these countries in meeting their needs in these two areas. This problem area is one in which more concerted AID assistance toward infrastructure-building, and increased training and technical assistance are needed and will be offered in the future.

Pesticide Problems in Less Developed Countries

The following discussion of pesticide problems in less developed countries is intended to show the kinds of problems that crop protection and public health workers and decision makers are facing, and to show those problem areas that can, and those that cannot, be directly affected by AID pest management policies and programs. This discussion is not necessarily complete, nor is it intended to be a checklist for pesticide procurement, distribution, and use. The pesticide problems are not presented in order of importance, but in approximate order of occurrence in the process of procurement, distribution, and use of pesticides. Not all of these problems will occur in all places where pesticides are used, but some of them have occurred or will occur in most places. It is emphasized that these problems are not specifically related to AID-financed pesticides, but arise in connection with most or all pesticide activities in less developed countries, regardless of the source of any given pesticide.

Pesticide Selection and Procurement

Factors To Be Considered--

* Pest and pesticide management capabilities of receiving organization.

* Selection of appropriate active ingredient, formulation, and container (construction, quality, and size).

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* The term "agromedical" has been coined to emphasize the interrelationship of problems associated with and the consequences of pest management activities in the areas of agriculture and health. This concept, first conceived by FAO in 1966 by the initiation of a series of regional seminars on the safe and effective use of pesticides in agriculture and public health (sponsored by the FAO/Industry Cooperative Program) was further developed by the AID/University of California Pest Management Project and presented in seminars and workshops in less developed countries (see Chapter I, page 68 and Chapter II, page 112).

* Pesticide product's stability and performance characteristics (contents and container including labeling) must be suitable for the climate of the receiving country, especially in the case of tropical countries.

* Label text appropriate for intended use in less developed country (active ingredient description and content, directions for use, safety precautions, and language).

* Effectiveness on target pest(s), selectivity, effects on beneficial insect predators and parasites, likelihood of development of resistance of target pest(s), and compatibility with target agroecosystem.

* Toxicity to humans.

* Toxicity to other nontarget species (domestic animals, wildlife, fish, and lower flora and fauna).

* Given the actual time requirements of AID's pesticide procurement procedures (see Chapter I, page 14, and Table 18, page 54, respectively), can the requested pesticide be made available where it is needed when it is needed (2)?

Restrictions--

* Supply technical pesticides only to countries that have the capability, resources, facilities, and supplies (solvents, emulsifiers, dry carrier and diluent materials, and containers) to properly formulate, repackage, and relabel the product.

* Supply formulated pesticide products in bulk (large containers) only to countries that have the capability, resources, facilities, and supplies to properly repackage and relabel the product.

* Supply pesticides of high acute mammalian toxicity only to countries and for purposes where they can be used safely (trained pesticide operators and workers, mechanized application equipment, appropriate protective clothing and equipment, etc.).

* Do not supply pesticides containing toxic or other harmful impurities or pesticides in which such impurities are likely to develop during handling and (possibly prolonged) storage.

Field Problems--

* Some less developed countries have no pesticide laws and regulations.

* Many less developed countries that have pesticide laws and regulations have no mechanisms for effective enforcement.

* The specifications for pesticide quality and performance developed by FAO for use in international trade have been accepted by 42 countries to date, but have not been universally adopted.

* Exposure of workers in local pesticide formulation and packaging plants can result from inadequate safety precautions and equipment and lack of technical knowledge. High temperatures may aggravate these problems because protective clothing becomes unwearable and vapor hazards increase.

Pesticide Transportation, Storage, and Distribution

Factors To Be Considered--

* Stability of pesticide product (contents and container) during ocean transport, overland transport in less developed country, loading and unloading, and storage under hot and humid climatic conditions.

* Suitability of container size and type for intended use.

* Availability of transportation means to move the right pesticide to the right place at the right time.

Field Problems--

* Deterioration of pesticides (containers, labels, or contents) during transportation and storage.

* Contamination of food or other items from pesticide leakage during ocean transport, overland transport, or storage.

* Refilling of pesticides into unlabeled, unsuitable containers (soft drink bottles, paper bags, household vessels, etc.).

* Diversion from intended use (loss, theft, untimely delivery, pest problem changed or disappeared between request for and delivery of pesticide, etc.).

Pesticide Application

Factors To Be Considered--

* Is control of the pest necessary (economic damage threshold)?

* Is use of a pesticide the best way to control the pest?

* Is the pesticide to be applied suitable and appropriate (biologically, physically, and chemically) for the intended purpose?

* Compatibility of the pesticide application with other elements of the target agroecosystem (effects on predators, parasites, pollinating insects, and other beneficial ecological factors).

* Appropriate timing and rate of application.

* Is the application technique to be employed appropriate?

* Is the application equipment suitable and properly calibrated for the intended use?

* Do pesticide operators and their supervisors understand the directions for use? Do they have (and use) appropriate protective clothing and equipment (if needed)?

* Suitable weather conditions (avoidance of pesticide drift).

* Protection of people, livestock, etc., in or near the target area.

Field Problems--

* Lack of personnel trained in pest and pesticide management.

* Inadequate information on proper use of pesticides due to inadequate label information (e.g., wrong language, target crop or pest(s) not covered in use directions) or illiteracy of pesticide operators.

* Indiscriminate use of pesticides (wrong pesticide, wrong time, wrong rate of application).

* Poor performance of pesticide formulations in local waters, especially after tropical storage, or if formulated locally with inadequate ingredients or quality control.

* Malfunctioning of application equipment.

* Available pesticide formulation and available application equipment not compatible. For example, knapsack sprayers are widely used in less developed countries, but not all pesticide formulations are suitable for use in these sprayers.

* Exposure of pesticide operators, workers in treated fields, or of people and livestock living in or near treated areas. This risk is especially great when operators and others were previously accustomed to the use of a less toxic pesticide (e.g., substituting parathion for DDT), or when the pesticide contains unexpected toxic impurities.

* Lack of practical protective clothing wearable under hot, humid conditions.

* Deleterious effects on hearing of operators of motorized knapsack sprayers.

* Lack of medical care and facilities and of appropriate pesticide antidotes in case of pesticide accidents.

Postapplication Activities and Events

Factors To Be Considered--

* Postapplication isolation of treated areas.

* Monitoring of pesticide residues in treated crops, livestock, and in appropriate environmental samples.

* Cleaning, repair, and maintenance of pesticide application equipment, and of protective clothing and equipment.

* Safe disposal of emptied pesticide containers.

Field Problems--

* Exposure of agricultural workers entering treated fields too soon after application for cultivation or harvesting work.

* Poisoning of people or livestock from reuse of pesticide containers for storage or transportation of water, food, feed, etc.

* Lack of practical, feasible methods and equipment for disposal of used pesticide containers.

* Rapid deterioration of pesticide application equipment under tropical conditions.

* Lack of chemical and biological monitoring capabilities for pesticide residues.

* Lack of information on pesticide residues in treated crops or livestock, food, feed, water, fish, and other elements of the environment.

* Development of resistance of target pest(s).

* Resurgence of target pest(s) due to destruction of natural enemies.

* Development of previously unimportant pests to damaging proportions.

* Need to use increasing rates or more frequent applications of pesticides unless integrated pest management principles and procedures are employed.

Remedies to Less Developed Countries' Pesticide Problems

While some of the pesticide problems cited may also occur in developed countries and in temperate climates, many others are peculiar to the operating and environmental conditions that prevail in less developed countries in tropical and subtropical climatic zones.

Most of these problems can only be solved by the less developed countries themselves. Many of these problems cannot be improved or resolved for either the short or long term by applying to them domestic United States pesticide laws, regulations, and restrictions. For instance, parathion and several other insecticides of high acute mammalian toxicity are registered and recommended in the United States for use on many crops that are also grown in less developed countries, including cotton, rice, corn, sorghum, cereals, beans, peas, peanuts, soybeans, and many fruit and vegetable crops. These United States registrations do not guarantee, however, that parathion and similar products are suitable for use on the same crops in less developed countries. Populations of injurious as well as of beneficial insects on these crops may differ between countries. Furthermore, wearing of the protective clothing and equipment (including rubber boots, impervious hat, impervious suit or coat, gloves, and mask or respirator) recommended for workers handling

and applying pesticides of this order of toxicity in the United States is simply not possible under the hot and humid conditions that prevail in many warm climates during the growing season, and practical light protective clothing wearable under such conditions has not been developed.

On the other hand, pesticides whose registrations have been discontinued in the United States may be the products of choice for certain pest control purposes in less developed countries, e.g., dieldrin against desert locusts and tsetse flies. A certain degree of insecticide persistence is necessary for these and other insect control purposes, and even persistent pesticides degrade more rapidly under the hot and humid environmental conditions of the tropics than they do in the temperate zone. Further, lower acute toxicity and lower cost may make some of the more persistent pesticides more attractive to the less developed countries than the more expensive, U.S. preferred substitutes.

Under the "interim regulations" that currently govern AID's pesticide activities (see Chapter II, page 108), the Agency does not finance procurement of pesticides specifically restricted by the interim regulations, and avoids participation in any projects in less developed countries involving the use of such pesticides. As a result, less developed countries may obtain funding for the United States-restricted pesticides from other sources or from donors who may not share AID's environmental concerns, depriving the Agency of any further influence on such projects, and of the opportunity of assisting these countries in avoiding unintended and adverse effects of pesticides. Thus, AID actual or potential withdrawal from a project does not ensure that the project will be cancelled or modified to address the policies the Agency would have wanted instituted.

FUTURE PEST MANAGEMENT POLICIES, STRATEGIES, AND PROPOSED ACTIONS

The policies that will govern, and strategies that will be applied to AID's future pest management activities are set forth in this section. These policies and strategies will complement the implementation of Alternative B which emerged as the most appropriate program for most countries and program areas. (For a definition of Alternative B and the reasons which led to the selection of this alternative as the most appropriate program, the reader is referred to Chapters III, IV, and V of this EIS).

The policies and strategies discussed in this section, and the actions that will be taken to implement them, were developed on the basis of the information and conclusions presented in the preceding chapters and sections of this EIS. The comments received from United States and international agencies and organizations, foreign governments, and individuals in response to the distribution of the draft EIS dated September 30, 1976 (see Chapter VII and Appendix H) were also taken into consideration in the development of these policies and strategies, and in the plans for their implementation.

Policies

Integrated Pest Management--

Establishment of integrated pest management systems and promotion of integrated pest management concepts, principles, and methods will be an integral part of AID's future pest management activities. Such activities will be aimed at assisting less developed countries in designing and operating economically and ecologically sound integrated pest management systems and procedures.

Infrastructure Support for Pest and Pesticide Management--

As pointed out in the preceding section of this chapter (page 325), the need for integrated pest management systems and the need for pest and pesticide management infrastructures in less developed countries are closely related. Many less developed countries currently do not have adequate infrastructures for the development and implementation of long-range, economically and ecologically sound pest and pesticide management programs as essential elements of their overall efforts to improve agricultural productivity and public health. Therefore, in its future pest management activities, AID will increase its assistance to less developed countries in the building and improvement of pest and pesticide management infrastructures. Such institutional strengthening assistance will include support for:

* Establishment and operation, or improvement of integrated pest management systems.

* Establishment and operation, or improvement of schemes for the regulation of pesticide usage (encouraging adoption of internationally developed model licensing, approval and labeling schemes, and of international pesticide residue tolerances).

* Adoption of pesticide quality standards (such as the "FAO specifications for plant protection products"), and establishment or improvement of facilities and procedures to monitor and enforce them.

* Strengthening of national health and agricultural programs ("agromedical approach"), with particular emphasis on training and technical assistance.

* Strengthening of less developed countries' capabilities to apply sound environmental planning and monitoring as an integral part of their crop production and public health systems and policies.

* Monitoring of the human and environmental health effects of pesticides.

* Collection of efficacy and safety data on pesticides.

International Leadership--

While AID's ability to influence the policies and actions of the governments of less developed countries does have limitations, the Agency recognizes that U.S. policies and actions in the pest management field are being watched carefully in many other countries. This situation affords opportunities for U.S. leadership by example, and by communicating to other countries U.S. positions on, or experiences with pest or pesticide management problems. In its future pest management activities, AID intends to exert a greater degree of leadership of this type in its bilateral and multilateral contacts with other countries.

For example, AID believes there is a need to reevaluate various methods of malaria control including malaria immunity and vaccination, chemotherapy, biological and chemical vector control methods, increasing the effectiveness of currently available insecticides, genetic control, and source reduction, and to establish priorities for further research and development in these areas.

Although this is a subject with which WHO might properly concern itself, there is no indication that WHO will do so. Rather than wait, AID plans to fund an international workshop for the purpose of dealing with these problems. The workshop will be organized through the auspices of an organization such as the National Academy of Sciences.

Chemical Pesticides--

Pesticides by themselves will provide only limited, short-term solutions to less developed countries' crop protection and other pest problems. Therefore, AID will discourage requests for pesticides unless they are to be used in economically and ecologically sound integrated pest management systems.

If and where pesticides are provided by AID, their selection will be governed, on a case-by-case basis, by the policies and guidelines of Alternative B as described in detail in Chapter III, page 214. These procedures take into account a pesticide's regulatory status in the United States, the requirements of the AID Environmental Procedures (Regulation 16, see Appendix C), the receiving country's needs, and previous experience (efficacy and safety) with the pesticide under conditions prevailing in the receiving country.

AID will not reissue or maintain a pesticide eligibility list.

Where pesticides are to be provided, an effort will be made to improve and speed up the pesticide procurement and delivery process. Time lapses of up to 18 months between initiation and completion of a procurement action result in pesticide hoarding, buildup of pesticide inventories that deteriorate in storage, diversion from intended use, etc.

In the public health (vector control) field, AID's close cooperation with WHO will be continued through formal coordination, meetings, and informally through regular personal contacts between staff members.

Strategies

Commodity Import Programs--

In the future, AID will discontinue financing pesticides under commodity import programs (CIP) except in a very limited number of cases involving emergencies or special needs. In this context, an emergency is defined as a situation in which a pest outbreak has occurred or is about to occur without the use of pesticides. The supply of pesticides on a special needs basis for a nonproject associated request will be made only after the request has been subjected to the same type of rigorous analysis as is required for project-related pesticides. (For a historical description of this type of support, refer to Chapter I, page 14.)

Pest Management Activites in Bilateral Projects--

Project requests for pesticides will be subject to all provisions of Alternative B. including determination of the current U.S. regulatory status of desired pesticide(s), and evaluation of safety and efficacy data under requesting country conditions. In addition, AID will ensure that integrated pest management principles and methods are being practiced to the extent practicable under the country's constraints or limitations on supporting staff, and the pesticide(s) are being used safely and efficiently. If AID's evaluation of these prerequisites reveals organizational,technical, or other supplemental needs (supervision, instruction, training, safety equipment, monitoring, health care, etc.), provisions for meeting such needs will be considered for the project.

Participation in Multidonor Projects--

In the case of multidonor contributions to specific projects (except where A.I.D. is a minor donor), AID will apply the risk/benefit analysis procedure to the evaluation of each project to reach a decision on our participation.

In those cases where AID is a minor donor to a multilateral project, AID will attempt to influence others to adopt its objectives and to incorporate its overall policy on pest management to the fullest extent possible.

Training and Technical Assistance--

Training and technical assistance are fundamental needs in less developed countries. There are a number of reasons for supporting such activities:

* There is a need to establish within a country the capability to solve its own problems.

* There is a need to build the confidence of a country in meeting its own problems.

* There is a need to allow the country to control its own development plans by establishing AID's training and technical assistance within the framework of national policies.

These three needs--capability, confidence, and control--can be met most easily by the cooperative efforts of those organizations most interested in seeing that integrated pest management programs become the vehicle by which less developed countries advance and improve their agricultural productivity.

These needs are amply supported by those organizations and individuals knowledgeable in the crop protection and vector control problems of less developed countries who were interviewed or whose reports were studied in the course of the preparation of this document. These organizations and individuals agree that in nearly all of the less developed countries, an overwhelming need exists for training and technical assistance in pest and pesticide management. AID's activities in this field through the "Pest Management and Related Environmental Protection Project" represent successful strategy. Evidence of this success is seen in the great interest in less developed countries in the pesticide management workshops and seminars conducted by the project, in the agromedical approach to pesticide management presented at these training activities, and in the special technical assistance services that have been provided.

Among all of AID's pest management activities, such workshops and seminars appear to be one of the most effective, especially if the multiplier effect emanating from its activities is taken into account. Therefore, AID plans to strengthen and expand these types of activities in order to provide more training and technical assistance in pest and pesticide management and infrastructure building in less developed countries.

Research Activities--

AID's current and future pest management-related research projects will be reviewed to determine if they are in agreement with and supportive of the overall pest management policies and strategies set forth in this document. This review will also consider to what extent research projects unilaterally supported by AID may overlap research programs of international agricultural research centers or other international organizations which receive substantial AID support through multidonor arrangements, or programs supported by other bilateral or multilateral donors.

In initiating new pest management-related research projects, AID will consider research needs emanating from the evaluation of pesticide problems in less developed countries. Special consideration will be given to problems encountered by small farmers, who do not seem to have received adequate attention from public or private research efforts to date. Examples of research needs of this type include the following:

* Development of liquid pesticide formulations which are not readily absorbed through the skin.

* Development of a malodorous additive suitable for incorporation into liquid pesticide formulations to prevent accidental drinking by humans, especially children.

* Development of light protective clothing wearable under hot, humid conditions, based on the concept of reducing exposure of pesticide operators, but not seeking the impossibile: complete elimination of exposure.

* Development of pesticide containers and of a pesticide container handling system meeting the needs of small farm pesticide users in less developed countries.

* Development of integrated pest management programs for basic food crops utilizing cultural, physical and mechanical control methods to the maximum possible extent and only employing chemical pesticides when absolutely necessary.

* Development of nonchemical methods for pest control such as the use of sex-attractants, antifeeding compounds, juvenile hormones and microorganisms pathogenic to pest and other biological-ecological methods.

In initiating new pest management-related research projects in the area of public health, AID will consider needs emanating from the evaluation of pest and vector-borne disease problems in less developed countries. Examples of research include:

* Development of environmentally acceptable chemical means of vector control.

* Use of advanced technology to reduce the need for pesticide applications.

* Development of alternative disease control methods which do not focus on vectors, such as malaria immunization and schistosomocidal drugs.

Implementation

Program Management--

In the past, AID has not had a comprehensive pest management policy, but rather a number of essentially isolated pesticide and pest management activities which had diverse origins and objectives.

The foregoing discussion shows that for best results in integrated pest management-crop production systems, all individual program elements must be well coordinated. Thus, in furtherance of its program objectives, AID will coordinate all its agricultural pest management activities with its public health activities, and provide in-house expertise as needed for program management. AID will also provide for coordination with related activities of other U.S. government and nongovernment agencies and organizations, international organizations, and other countries having parallel programs and concerns in less developed countries. The coordination and management of all AID agricultural pest management and public health activities may yield even greater benefits than the historical system to less developed countries as well as to U.S. taxpayers.

Resource Requirements--

AID has initiated an examination of the legal, administrative, and fiscal questions associated with implementation of the pest management policies and strategies outlined above. Preliminary conclusions are as follows.

All pest management policy goals as set forth above are within AID's present legislative authorization; no new or additional Congressional mandates are required.

Some of the new pest management policies and objectives can be and already are being implemented in current projects; some can be implemented by changing emphasis or priorities in existing programs. However, major

elements of the new policies require new resource commitments, primarily in the form of additional staff needed to implement the objectives of integrated pest management and infrastructure building. Additional resources will be required at AID/Washington and in the field to support an expanded program of technical assistance and guidance to less developed countries in both agriculture and public health.

This program expansion will require additional funding, a matter which is now under study by the Agency.

REFERENCES

Comments from UC/AID Pest Management Project Personnel

As part of the development of pertinent background information on factors influencing pest management activities in less developed countries, 30 scientists who served on the UC/AID Pest Management Project were contacted. Each was asked to comment on the same five subject areas. These five subject areas, as well as the names of the 30 scientists who responded to the inquiry, are listed as follows.

Discussion Areas for UC/AID Project Members and Associated Experts--

1. Adverse effects associated with the pesticides used in less developed countries.

2. Remedies to adverse pesticide effects.

3. Pesticide application by type of equipment (estimation of the percentage of pesticides applied in less developed countries by type of pesticide and type of application equipment).

4. Beneficial effects of AID pesticide activities in less developed countries.

5. Optimal use of funds for crop protection assistance in less developed countries.

Information received from these 30 scientists has been used to develop the strategies presented in this chapter. The personnel contacted were:

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CHAPTER VII

CONSULTATION, REVIEW, AND RESPONSE

INTRODUCTION

In response to the distribution of the draft EIS dated September 30, 1976, 28 letters of comment or acknowledgement were received. Listed below are the United States federal agencies, international organizations, other United States organizations, foreign governments, and individuals who either acknowledged receipt of the draft EIS or provided letters of comment.

U.S. Federal Organizations

Department of Agriculture. December 10, 1976, Mr. Errett Deck.

Agricultural Research Service, USDA. November 1, 1976, Mr. Carl W. Carlson.

Department of Health, Education and Welfare. November 29, 1976, Mr. George H. Deming.

Department of the Interior. December 6, 1976, Mr. Stanley D. Deremus.

Bureau of Oceans and International Environmental and Scientific Affairs, Department of State. November 26, 1976, Dr. Donald R. King.

Coast Guard. November 22, 1976, Captain D. J. Riley.

Federal Aviation Administration. November 12, 1976, Mr. Charles R. Foster.

Environmental Protection Agency. December 15, 1976, Ms. Rebecca W. Hanmer.

Council on Environmental Quality. December 16, 1976, Mr. Gary L. Widman.

Senate Foreign Relations Subcommittee. November 1, 1976, Mr. Rudy Russeau.

International Organizations

FAO. December 10, 1976, Mr. F. Albani.

WHO. November 19, 1976, Mr. J. Hamon.

WHO. November 24, 1976, via Department of State Telegram from U.S. Mission Geneva.

ILO. November 24, 1976, via Department of State Telegram from U.S. Mission Geneva.

UNEP. December 6, 1976, Mr. David A. Munro.

OECD. December 30, 1976, via Department of State Memorandum from U.S./AID Paris.

UNESCO. October 15, 1976, Mr. Louis G. Sleeper.

Other U.S. Organizations

Center for Law and Social Policy. December 15, 1976, Mr. Richard A. Frank and Dr. I. C. T. Nesbit.

National Research Council, National Academy of Sciences. October 7, 1976, Mr. Theodore M. Schad.

The Institute of Ecology. Undated, Dr. A. D. Hinckley.

Rachel Carson Trust for the Living Environment, Inc. December 15, 1976, Ms. Shirley A. Briggs.

Rachel Carson Trust for the Living Environment, Inc. December 27, 1976, Ms. Shirley A. Briggs.

Threshold. November 29, 1976, Mr. James L. Aldrich.

Friends of the Earth. October 30, 1976, Mr. Erik Jansson.

Foreign Governments

Government of Guyana. November 15, 1976, via Department of State Telegram from Georgetown.

Government of Equador. December 14, 1976, via Department of State Telegram from Quito.

Government of Kenya. December 22, 1976, via Department of State Telegram from Nairobi.

Interested Individuals

Sumitomo Chemical America, Inc., November 18, 1976, Mr. Y. Sato.

The official comment letters received varied from acknowledgements with no comment to many pages of detailed constructive criticisms of both the draft EIS and the AID pest management programs. The U.S. Agency for International Development wishes to express its sincere appreciation for the valuable assistance provided by the many reviewers. Their comments and guidance have been very helpful in making suggested revisions in the EIS and in making major policy decisions concerning future AID pest management assistance programs for less developed countries. Copies of all letters of comment are contained in Appendix H.

REVIEW COMMENTS AND AID RESPONSES

Among the letters which contained detailed comments there were a number of concerns shared by more than one reviewer. In the interest of brevity, concerns common to multiple reviewers have been addressed as a single comment with pertinent reviewers listed.

There were also a number of comments provided by single reviewers. These comments have been paraphrased and addressed individually by reviewing agency.

Multiple Reviewer Comments and AID Responses

Comment: One of the fundamental concerns of many of the reviewers was that the draft EIS did not contain a clearly expressed description of the future AID pest management policies and programs.

Response: It is true that a detailed description of the AID future pest management policies and programs was not included in the draft EIS. However, the draft EIS did describe several alternatives and policy operations which were being evaluated by AID.

Based on further analyses of the program activities and alternatives set forth in the draft EIS, the future AID pest management program policies have been selected. The strategies, policies, and proposed actions for its future pest management program are discussed in detail in Chapter VI. The major policy issues included in the program definition are briefly summarized below.

- Continue to promote integrated pest management concepts, principles, and methods.

- Offer increased assistance to less developed countries in the building and improvement of pest and pesticide management infrastructures, as described on pages 325 and 333.

- Exert a greater degree of leadership in the international community by setting a good example, and by communicating U.S. positions on, or experiences with, pest or pesticide management problems to other countries.

- Provide only those pesticides selected on the basis of a case-by-case evaluation in conformance with the policies and guidelines set down under Alternative B. (Alternative B, the method of active ingredient selection that emerged as the most appropriate for most less developed countries, is discussed in detail in Chapter III, page 214.)

- Eliminate the concept of a pesticide eligibility list.

- Discontinue financing pesticides under commodity import programs, except in emergencies, and to respond to special needs for which rigid controls can be assured.

- Subject all requests for pesticides in AID-financed (bilateral) projects to all provisions of Alternative B, including determination of the U.S. regulatory status of desired pesticide(s), and evaluation of safety and efficacy data under requesting country conditions.

- Attempt to have AID policy prevail in multidonor projects in which AID participates if pesticide or pest management activities in such projects disagree with AID's pest management policies. If AID continues to participate, augment project with supporting assistance or environmental monitoring.

- Strengthen and expand future activities to provide more training and technical assistance in pest and pesticide management and infrastructure building in less developed countries.

- Review current and future pest management-related research projects to determine if they agree with and support the overall pest management policies and strategies set forth in this document; to determine the degree of overlap between AID-sponsored research and the research of international organizations; and continue to initiate new pest management-related research projects that give special consideration to the research needs emanating from the evaluation of pesticide problems in less developed countries and to the problems of small farmers.

- Coordinate all AID agricultural pest management and public health activities, and provide in-house expertise as needed for program management. AID will also coordinate with related activities conducted by other U.S. government agencies and organizations, by international organizations, and by other countries having parallel programs and concerns in less developed countries.

- Seek new and additional resources for future AID pest management programs. New resources will include additional staff, additional funds, and establishment of regional pest management specialist posts to be located in Missions.

Comment: Eleven reviewers of the draft EIS were concerned about the degree to which AID future pest management programs will be committed to integrated pest management concepts. These 11 reviewers are listed below.

U.S. Department of Agriculture, December 10, 1976.

U.S. Department of the Interior, December 6, 1976.

U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs, November 26, 1976.

Food and Agricultural Organization, December 10, 1976.

United Nations Environmental Programme, December 6, 1976.

Center for Law and Social Policy, December 15, 1976.

The Institute of Ecology, undated.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Friends of the Earth, October 30, 1976.

Government of Guyana, November 15, 1976.

Government of Kenya, December 22, 1976.

Response: The degree to which AID is committed to implement the concepts of integrated pest management in its future programs for less developed countries was not clearly stated in the draft EIS. In this document more attention was given to this area to show that AID is fully committed to the concept of integrated pest management in all future programs. The specific commitments to integrated pest management are given in Chapter VI in this document.

Establishment of integrated pest management systems and promotion of integrated pest management concepts, principles, and methods will be an integral part of AID's future pest management activities. Such activities will be aimed at assisting less developed countries in designing, establishing, and operating, or improving economically and ecologically sound integrated pest management systems and procedures. Future research, training and technical assistance, infrastructure building, provision of chemical pesticides, and AID participation in bilateral and multidonor projects will all be structured around AID's commitment to integrated pest management.

Comment: Seven reviewers expressed concern about the continued use of DDT in AID's malaria control programs. The reviewers are listed below.

U.S. Department of the Interior, December 6, 1976.

U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs, November 26, 1976.

Council on Environmental Quality, December 16, 1976.

World Health Organization, November 19 and 24, 1976.

Center for Law and Social Policy, December 15, 1976.

The Institute of Ecology, undated.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Response: In compliance with its mandates from the U.S. Congress, AID has been an active participant in the worldwide campaign against malaria for many years by supporting multilateral efforts, especially those of WHO, and by bilateral support of individual countries' antimalaria programs. The Agency has thus made important contributions to the results achieved in the global fight against malaria to date.

Based on the evidence summarized in Chapter II of this EIS concerning the performance of DDT in antimalaria programs, including efficacy, safety to humans, unintended secondary effects and cost effectiveness, and considering the current availability and performance of alternatives, it is AID's conclusion that DDT continues to be necessary and useful in antimalaria programs where vector resistance or other factors do not mitigate against its use (see pages 174 through 200).

In arriving at this conclusion, AID has taken into account that three prestigious organizations have recently, independently of one another, performed comprehensive evaluations of the benefits and risks associated with the use of DDT against disease vectors in the public health field, namely:

The World Health Organization,

The National Academy of Sciences, and

The U.S. Environmental Protection Agency.

All three have arrived at the same conclusion, i.e., that the benefits of the use of DDT in vector control programs outweigh actual and potential risks to the health of man and his environment.

Therefore, currently identified AID pest management activities include provisions for continued financing of DDT for antimalaria programs, and AID plans to continue to assist WHO and national governments of less developed countries in their efforts to reduce, control or eradicate malaria. AID also plans to continue its support of the search for and development of alternative methods of malaria and malaria vector control, and of integrated systems for malaria control or eradication, as reviewed in Chapter I (page 74) and Chapter II (page 157) of this EIS.

As in the past, these policies and plans will be carried out within the framework of AID's overall policies, objectives and priorities and will be subject to all applicable AID rules and regulations. In addition, they will be subject to continuous review and reappraisal, and to change if and when new facts or information so dictate.

Comment: Five reviewers expressed concern about the integration of the environmental review procedures into the proposed future program. The five reviewers sharing this concern are listed below.

U.S. Environmental Protection Agency, December 15, 1976.

Council on Environmental Quality, December 16, 1976.

Center for Law and Social Policy, December 15, 1976.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Threshold, November 29, 1976.

Response: The general requirements of the new AID Environmental Procedures (Regulation 16) became effective on June 28, 1976, and apply to all future AID pest management activities. These procedures ensure that

an assessment of the environmental effects will be an integral part of the AID decision-making process. Within the framework of this regulation, future AID activities will be conducted so that the environmental consequences of all proposed activities are identified and considered by AID and the host country, and that the indigenous capability of the LDC to evaluate potential environmental effects as well as to implement effective environmental protection measures will be strengthened.

The requirements of these Environmental Procedures are discussed in Chapter III (page 211) and are contained in their entirety in Appendix C (Volume II). Briefly stated, this regulation incorporates environmental considerations into the established AID procedures for initiating and funding all project or program activity.

Under this regulation, AID uses six internal documents in the review process for proposed activities: Project Identification Document (PID), Project Review Paper (PRP), Project Paper (PP), Program Assistance Initial Proposal (PAIP), Program Assistance Review Document (PARD), and Program Assistance Approval Document (PAAD).

The new environmental procedures are applicable to the development and implementation of all AID projects or program actions. These procedures begin with the use of the initial environmental examination and a threshold decision. If the threshold decision is such that a proposed action is not a major action that will have a significant effect on the human environment, then a negative determination is made, which states that AID will not develop an Environmental Impact Statement (EIS) or an Environmental Assessment (EA). If the proposed action will have significant environmental consequences, then an EA or EIS will be developed, except for emergency situations.

The integration of the U.S. regulatory status of pesticides into Regulation 16 procedures is described under Alternative B (page 214).

Comment: Monitoring of the environmental and human health consequences of AID's future pest management programs was of concern to the four reviewers listed below.

U.S. Department of the Interior, December 6, 1976.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Threshold, November 29, 1976.

Friends of the Earth, October 30, 1976.

Response: Because of the inherent difficulties in monitoring the use and effects of pesticides supplied under a Commodity Import Program (CIP), AID will discontinue financing any pesticides through its CIP activities except under extraordinary situations and situations in which proper management can be assured. Even under these circumstances, pesticides will only be financed after AID is assured that an appropriate monitoring element will be incorporated in the project. When AID participates in multidonor projects, it will encourage proper environmental monitoring to be designed into the program.

In its future pest management projects, AID will increase its assistance to less developed countries in the building and improvement of pest and pesticide management infrastructures. Such institution-strengthening assistance will include support for strengthening of less developed countries' capabilities to apply sound environmental planning and monitoring as an integral part of their crop protection and public health systems and policies, and support for monitoring of the human and environmental health effects of pesticides.

In bilateral pest management projects AID will ensure that the pesticide(s) are being used safely and efficiently by providing that monitoring of the environmental and human health consequences of pesticide use is incorporated into the project.

Comment: Four reviewers expressed concern about the processes by which active ingredients would be selected in AID's pest management program. These four reviewers are listed below.

U.S. Department of the Interior, December 6, 1976.

U.S. Environmental Protection Agency, December 15, 1976.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Government of Kenya, December 22, 1976.

Response: Historical data as presented in Chapter I and Appendix B of the draft EIS were misinterpreted by some reviewers. Specifically, the pesticide eligibility list, which had been a part of the historical program, was thought to be included in the future AID program. This is not the case, however, and Chapter VI of this document clearly states that AID will not reissue or maintain a pesticide eligibility list nor will it continue financing pesticides under commodity import programs except in a very limited number of cases involving emergencies and special needs.

Instead, the selection of pesticides in the future will be governed, on a case-by-case basis, by the policies and guidelines set forth under Alternative B described in detail in Chapter III, page 214. The new procedures that will be used in the pesticide selection process take into account a pesticide's regulatory status in the United States, the requirements of the AID Environmental Procedures (Regulation 16), the receiving countries' needs, and previous experience (efficacy and safety) with the pesticide under conditions prevailing in the receiving country.

The general requirements of the new AID Environmental Procedures (Regulation 16) would apply to all future AID pesticide selections. These procedures ensure that an assessment of the environmental effects will be an integral part of the AID decision-making process. Within the framework of this regulation, future AID pesticide selections will be made so that the environmental consequences of all proposed activities involving the pesticides are identified and considered by AID and the host country.

Comment: Three reviewers listed below expressed the desirability of including more specific data in the draft EIS.

U.S. Department of the Interior, December 6, 1976.

U.S. Environmental Protection Agency, December 15, 1976.

Threshold, November 29, 1976.

Response: The degree of detail included in the draft EIS is considered to be appropriate for a programmatic environmental impact statement. It appears that these reviewers were accustomed to dealing with very detailed project environmental statements in which considerable specific detail could be included, both in the areas of the proposed activity and the areas of potential impact. It should further be noted that new AID environmental procedures (Regulation 16) will be applied to all AID activities, including pest management programs. Regulation 16 has been included in Appendix C for the reader's convenience.

Comment: Two reviewers listed below expressed concern about the nature and extent of AID influence and leadership in pest management programs in less developed countries.

U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs, November 26, 1976.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Response: It will be the policy of AID to take a leadership role in worldwide pest management activity. The Agency's effort to this end will be both active and exemplary in nature, and will have a specific objective of helping less developed countries develop their capacity to evaluate the impacts of their activities, based on a sound environmental assessment.

While AID's ability to influence the policies and actions of the governments of less developed countries is limited, the Agency recognizes that U.S. policies and actions in the pest management field are being watched carefully in many other countries. This situation affords opportunities for exercising leadership by way of example, and by communicating U.S. positions on, or experiences with, pest or pesticide management problems to other countries. In its future pest management activities, AID intends to exert a greater degree of leadership of this type in its bilateral and multilateral contacts with other countries.

As an example, AID believes that there is a need to reevaluate various methods of malaria control including malaria immunity and vaccination, chemotherapy, biological and chemical vector control methods, increasing the effectiveness of currently available insecticides, genetic control, and source reduction, and to establish priorities for further research and development in these areas. AID is proceeding to organize an international workshop for the purpose of dealing with these problems. The workshop will be held under the auspices of the National Academy of Sciences.

Comment: Three reviewers listed below were concerned about AID policies relating to the development of pest management infrastructures in less developed countries. Specifically, they were concerned about the emphasis AID would place upon programs to develop adequate infrastructures for managing pest control activities.

U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs, November 26, 1976.

U.S. Environmental Protection Agency, December 15, 1976.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Response: Many less developed countries currently do not have adequate infrastructures for the development and implementation of long-range, economically and ecologically sound pest and pesticide management programs as essential elements of their overall efforts to improve agricultural productivity and public health. Therefore, in its future pest management activities, AID will increase its assistance to less developed countries in the building and improvement of pest and pesticide management infrastructures. Such institution-strengthening assistance will include support for: improvement of integrated pest management systems, improvement of schemes for the regulation of pesticide usage, adoption of pesticide quality standards, strengthening of national health and agricultural programs, strengthening of capabilities to apply sound environmental planning and monitoring, and collection of efficacy and safety data on pesticides.

Comment: Three reviewers listed below questioned the specific selection of alternatives for evaluation in the draft EIS.

Center for Law and Social Policy, December 15, 1976.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Threshold, November 29, 1976.

Response: As part of the draft EIS (Chapter III), a set of alternatives for the future AID pest management program was selected based on the currently identified pest management activities (potential pest management activities that can now be identified, i.e., from the present time through CY 1978). The major emphasis in selection of the alternatives for analysis was given to the variation of pesticide activity.

This approach was felt to be most appropriate not only because the use of pesticides (pesticide activity) has the greatest potential for environmental impact of all the elements of a pest management program, but also to be responsive to the "reasonable alternatives" specified by the stipulation (see Appendix E). The alternatives specified in the subject stipulation for inclusion in the EIS were:

1. Terminating or temporarily suspending all or part of the pest management program, including pesticide activities (Alternative E).

2. Providing assistance for forms of pest management other than the use of pesticides (Alternative D).

3. Requiring user compliance with standards, either those promulgated by EPA for use of pesticides in the United States (including cancellations, suspensions, restricted uses, and label restrictions) or some other standards (Alternatives B and C).

The potential impacts of these four alternatives as well as those of the pest management programs as they were conceived prior to December 1975 (Alternative A) have been used as the bases for determining the best overall program for AID's future pest management activities, as judged by their impact in promoting overall environmental quality in the long term and minimizing adverse environmental impacts in reaching short-term goals. The findings from the analyses have been integrated into the AID strategy and policy for its future pest management program, as given in Chapter VI.

Comment: Two reviewers listed below questioned the adequacy of the pesticide profiles presented in Appendix B of the draft EIS as the basis on which to evaluate future AID pesticide activities and their impacts.

Center for Law and Social Policy, December 15, 1976.

Rachel Carson Trust for the Living Environment, Inc., December 15 and 27, 1976.

Response: Brief profiles were developed for 16 active ingredients identified as being potentially involved in currently identified AID pest management activities. These profiles were presented in Appendix B of the draft EIS along with historical data on pesticides that had been used in AID programs. However, these profiles were never intended to be the basis for evaluation of specific projects or the basis for risk-benefit analyses. Rather, they were intended for use in developing general impacts appropriate for a programmatic EIS.

The evaluation of all pesticides for future AID pest management programs will include not only basic data on the physical, chemical, and biological properties of the active ingredients (as summarized in the 16 profiles in Appendix B), but also the current regulatory status of the pesticide in the United States, as well as its history of safe use and efficacy in the host country.

Many of the comments of the reviewers on the individual pesticide profiles have been incorporated in the pesticide profiles presented in Appendix B of this document.

Comment: Two reviewers listed below were concerned about the lack of attention in the draft EIS to problems surrounding the use of pesticides in rice paddies also being used to culture fish in Asia.

U.S. Department of the Interior, December 6, 1976.

Threshold, November 29, 1976.

Response: Rice grown in flooded fields or paddies is the most important cereal grain for millions of people in Southeast Asia. However, human diets based on rice are often deficient in protein; therefore, sources of such proteins must be carefully considered in all food production and preservation programs. One of the important sources of protein for human diets is fish grown concurrently with rice (1,2). In addition to such cultures, the culture of fish in freshwater ponds and brackish ponds and the harvest of fish from natural freshwater and saltwater areas provide significant volumes of high-protein food.

One reviewer specifically cited data on Indonesian fish culture in rice paddies and indicated that 3,000,000 ha of paddy fields were being actively used for fish culture and had the potential to produce 600,000 tons/year. One data source on rice paddy fish culture in Southeast Asia indicates that Indonesia in the early 1960's had about 4,500,000 ha of wet rice fields with only 67,000 ha used for fish culture (1). However, another source reports that the four main islands of Indonesia in the late 1960's had 133,438 ha of rice paddies used for fish culture. The proportion of the total rice paddy systems utilized for fish culture in various countries varies from less than 1% to nearly 28%. The following data lend some perspective to the subject of fish culture in rice paddies in Southeast Asia.

Country	Wet rice fields in hectares: Total	With fish culture	Percent with fish culture
Indonesia	4,567,000	67,000	1.5
Malaysia	360,000	45,500	14.5
Pakistan	55,400	12,000	27.6
Japan	2,999,500	8,500	0.3
Taiwan	528,000	8,000	1.5
India	5,764,411	1,619	0.03
Vietnam	4,069,540	1,550	0.04
Total	18,343,851	144,169	0.79

Source: FAO Fisheries Biology Technical Paper No. 14, 1962 in Reference 1.

During the past several years the development of new genetic strains of rice and the intensification of rice culture have resulted in the need for improved methods of control of insect pests of rice. One of these pests, the rice stem borer, causes severe reductions in rice yields, and use of chlorinated hydrocarbon insecticides to control it has adversely affected the culture of fish in the same waters. In the amounts used and the frequency of application required for rice stem borer control, most of the organochlorine pesticides are toxic to the species of fish cultured. It has been found that mixing the pesticide with the irrigation water is the most efficient method of application, but this renders the area unsuitable for fish culture. Eventual release of these treated waters to natural streams also contributes persistent pesticides to the environment where they may be accumulated through the food webs and cause undesirable residues in natural and cultured fish stocks being utilized for human food.

In general, the impacts of using persistent and toxic pesticides in wet rice culture are: (a) direct mortality of cultured fish in rice fields or the loss of production potential; and (b) accumulation of undesirable residues in both cultured and naturally produced fish.

Although such severe impacts of using pesticides in wet rice cultivation have been observed, the currently identified AID pest management program for Southeast Asian countries (through CY 1978) does not include any pesticides for use in food production and preservation programs except for small amounts designated for research and demonstration projects in Bangladesh. These pesticides do not include any for which the registration for use in the United States has been finally suspended or cancelled, or any chemically related pesticides. It is anticipated that the currently identified AID pest management activities in Southeast Asia will have no adverse

effect on the nature and extent of freshwater, brackish water, or marine fisheries and will not contribute to pesticide residues in aquatic organisms used for human food.

REFERENCES

1. Kok, L. T. 1972. Toxicity of Insecticides Used for Asiatic Rice Borer Control to Tropical Fish in Rice Paddies. In M. T. Farvar and J. P. Milton (Eds.) The Careless Technology: Ecology and International Development. Natural History Press, Doubleday, New York.

2. Hardjamulia, A., and S. Kusumadinata. 1972. Preliminary Experiments on the Effect of Thiodan and Endrin on Fish Culture in Indonesia. Indo-Pacific Fisheries Council Proceeding 15 (2).

Individual Reviewer Comments and AID Responses

Many of the reviewers expressed individual comments not shared by other reviewers. These separate comments are given individual responses under the subheading of the reviewing agency or organization.

U.S. Federal Organizations--

U.S. Department of Agriculture--

Comment: The reviewer felt that the evaluation of the overall impacts of the AID pest management program for food production and preservation presented in Table 50 of the draft EIS (Table 56, page 292 of this document) should be altered to acknowledge that benefits can accrue to wildlife from pesticide activities.

Response: Potential benefits of pest management programs to wildlife were considered in the development of this table; however, the evaluations are so general that it was not possible to include a degree of detail adequate to show these potential benefits to wildlife.

Comment: The reviewer stated that if pesticide and pest management were developed into practicable, well-conceived activities, the very nature of this success would preclude irretrievable losses of wildlife.

Response: The draft EIS presented only the possibilities of wildlife losses that could occur under the alternatives evaluated. The wildlife habitat losses that may result from both public health and food production and preservation programs are unavoidable secondary losses.

U.S. Department of the Interior--

Comment: The reviewer was concerned about the potential impact of persistent pesticides on fish populations and fishery resources as human food.

Response: Chapter IV has been revised to recognize the potential impacts of pesticides on fishery resources in general. The discussion of this matter is given in the General Impacts section under Food Production and Preservation Programs, page 231.

U.S. Environmental Protection Agency--

Comment: The reviewer felt that the process for assessing the environmental impacts of AID's pest management programs should be clarified.

Response: Throughout the EIS, primary emphasis was given to evaluating various alternatives and their impacts for pesticide activity. Alternative B has been shown in Chapter IV to be the best of the alternatives as far as pesticide activity is concerned. The detailed methodology for evaluating the specific pesticides to be used in future pest management programs under Alternative B is given in Chapter III, page 214. In addition to the procedures given in Chapter III, which are specific to pest management activities, it is important to note that Regulation 16 outlines the AID procedures for environmental analysis of all AID programs, including all pest management activities (see Appendix C).

Comment: The reviewer recommended that the programmatic EIS be updated annually.

Response: AID feels that consideration of the advisability of an annual update of the EIS should not be undertaken until AID has gained experience in the conduct of the revised program as outlined in the EIS.

Comment: The reviewer was concerned that AID seems to assume that pesticides registered for use in the United States are suitable for use in pest management programs everywhere, and that pesticides which have been cancelled or suspended by EPA should never be used in less developed countries.

Response: It was not intended to convey that impression. As outlined in Chapter III, the initial evaluation of pesticides to be used in the AID pest management program will be keyed to the current status of registration in the United States. Other factors to be considered in the selection of pesticides include the efficacy and safety of the pesticide in the host country.

Comment: The reviewer suggested that five additional activities be undertaken by AID:

1. Initiate research efforts, and assist the recipient countries in conducting research efforts to determine such relevant items as: (a) essential baseline data on all aspects of integrated pesticide management, (b) the suitability of nonchemical versus chemical pest control methods, and (c) development of procedures for pesticide monitoring.

2. Broaden the expertise of its technical assistance teams.

3. Audit the programs periodically to assure that they were conducted properly and to determine whether the effects predicted were actually obtained.

4. Assure that all pesticides approved for use in recipient less developed countries are properly labeled.

5. Give the recipient countries all relevant information concerning the pesticides to be used.

Response: These additional activities have been largely incorporated into the future AID program as described in Chapter VI, pages 332 through 339.

Council on Environmental Quality--

Comment: The reviewer stated that any DDT proposed for use as part of the malaria vector control program, although exempted from review under the stipulation, should be covered by an environmental analysis.

Response: All pest management activities, including those involving DDT in malaria control programs, are subject to the AID environmental procedures, as set forth in Regulation 16 (Appendix C). Further, all future pest management activities will be subject to the specific environmental analyses procedures described in Chapter III (page 214) and in Chapter VI.

Foreign Relations Subcommittee of the United States Senate--

Comment: The reviewer was concerned that the draft EIS did not include a description of problems encountered in the use of malathion in malaria control programs in Pakistan.

Response: At the time the draft EIS was finalized the details on this particular episode were not available. However, this final environmental impact statement does contain a description of this situation in the General Impacts section of Chapter IV, page 226.

Other U.S. Organizations--

Center for Law and Social Policy--

Comment: The reviewer stated that AID has not provided an alternative that includes requiring user compliance with standards promulgated by EPA or some other standards.

Response: Alternative C, to the extent it would continue application of the procedures established as a result of the stipulation in AID's environmental litigation, does rely on standards established by EPA. Alternative B also utilizes EPA standards to determine the degree of review required for requests for pesticides.

Comment: The reviewer expressed concern that AID, in the future, should devote adequate resources to its pest management activities.

Response: AID has reexamined the resource requirements necessary to implement the pest management policies and strategies outlined in Chapter VI. The preliminary conclusions reached with regard to these examinations are shown in Chapter VI, page 338.

In brief, AID will commit additional resources in the future in the form of additional staff, additional funds, and new programs to assure that the new AID pest management policies and strategies are properly carried out.

Comment: The reviewer felt that AID is inconsistent in stating its ability to influence pest management programs in less developed countries.

Response: AID does not feel that statements in the draft EIS are inconsistent. AID's influence on the development strategies and priorities of recipient less developed countries is limited by such considerations as individual national policies, needs, priorities, and perceptions of the relative importance of environmental quality versus economic development. However, AID-supported pest management activities present the agency, and thus the United States, opportunities for influencing the quality of pest management practices in less developed countries. The limited scope of AID-funded pesticide activities in view of total use does, however, limit the degree to which AID can directly influence global pesticide activity.

Comment: The reviewer stated that AID should reassess its role in influencing FAO and WHO toward adopting stricter and more prudent environmental standards.

Response: Although AID's ability to influence the policies and actions of FAO and WHO is limited, the Agency recognizes that U.S. policies and actions in the pest management field are being watched carefully by these organizations. This situation again affords AID with opportunities for exercising leadership by way of example, and by communicating U.S. positions on, or experiences with, pest or pesticide management problems to FAO and WHO. In its future pest management activities, AID intends to exert a greater degree of leadership of this type in its contacts with these organizations.

Comment: The reviewer stated that the draft EIS does not address the recommendations to AID concerning its pest management programs provided by the National Academy of Science Committees in 1970.

Response: These recommendations have been addressed in Chapter II of this document.

Rachel Carson Trust for the Living Environment, Inc.--

Comment: The reviewer referred to the well-known episodes of leptophos intoxification in Egypt.

Response: The pesticide activities leading to this episode were not funded by AID.

Comment: The reviewer questioned the methods to be used to ensure that host countries are properly advised as to the health and environmental hazards of pesticides to be provided.

Response: The future AID pest management policies and strategies given in Chapter VI are directed toward ensuring that host countries are properly advised as to the health and environmental hazards of pesticide usage, both those provided by AID and those procured from other sources. This advice will be forthcoming in infrastructure building programs, integrated pest management programs, pesticide procurement actions, multilateral and bilateral projects, training and technical assistance programs, and as the result of research activities. AID will determine the safety and efficacy of pesticides in host country environments and in the hands of host country citizens, and transmit this information to the host countries.

Details of AID's commitment to advising and instructing people in less developed countries as to the health and environmental hazards of pesticides are given in Chapter VI.

Comment: The reviewer stated that no mention is made of the findings of the team sent by the National Academy of Sciences to study pest management methods in China in 1975.

Response: The published report of the National Academy of Sciences was not available during the development of this EIS.

Comment: This reviewer suggested 10 recommended procedures and areas of emphasis (see page 339, Volume II).

Response: These recommendations were considered in the development of future programs as outlined in Chapter VI (see pages 332 through 339).

Comment: The reviewer was concerned about the tables displaying summaries of the impacts of the five alternative program possibilities in key areas (Tables 48 through 51 for the draft EIS; Tables 54 through 57, pages 289 through 293 of this document). Specifically, why Alternative C would be more detrimental to the environment in some cases than Alternatives B, D, and E was not understood.

Response: The Stipulation, Interim Pesticide Regulations, and the Court Order of December 5, 1975, did not prohibit the use of any pesticide for public health purposes if AID determined that significant harm would occur without its use. Since Alternative C was based on these guidelines, it was concluded that the environmental effects of public health programs, with persistent pesticides, would be equivalent to Alternative A. Alternative B presupposes additional analysis of pesticide use relative to efficacy and environmental safety and should result in more reasoned and rational pest management programs for public health purposes. Alternative D assumed no use of pesticides which should reduce adverse environmental effects as compared to Alternative C. Alternative E, "no program," would produce no significant impacts, beneficial or adverse, attributable to AID.

In food production and preservation programs the conditions are not similar because the constraints on provision of pesticides are more stringent. Careful examination of Table 56 will reveal that the ratings of environmental impacts of the alternatives for food production and preservation programs are a logical progression from Alternative A, moderate adverse impact, to E, no identifiable impact. The changes are all related to the assumed uses of pesticides as part of hypothetical alternative pest management programs and to the degree of analysis involved under each alternative.

The overall perspective of these tables is that the scope of AID's provision of pesticides to less developed nations is small in comparison to the total amount used in those nations.

Comment: The reviewer expressed some confusion concerning the place of AID's emphasis on infrastructure building in host countries.

Response: While it is true, historically, that AID has not emphasized infrastructure building in host countries as a major objective, the future AID pest management program will include emphasis in this area. Chapter VI has been modified to reflect this emphasis.

Comment: The reviewer questioned the WHO estimates of the future DDT requirements for use in antimalaria programs.

Response: The WHO estimates were used because there does not appear to be any other competent source of such estimates available.

Comment: The reviewer questioned the advisability of developing the biologically degradable analogs of DDT.

Response: The appropriate sections of Chapter I have been modified to more clearly explain the advantages of these compounds (see page 75).

Comment: The reviewer questioned the use of BHC in antimalaria programs in Pakistan.

Response: BHC has been identified for use in the malaria program in Pakistan. This selection was based in part on the fact that BHC is still effective in Pakistan for the uses proposed, WHO recommendations, and the availability of domestically (Pakistan) produced material.

As with all future AID pest management program activities, the actual use of BHC in Pakistan will be subject to the risk-benefit type evaluation set forth for Alternative B in Chapter III of this document (see page 214).

Threshold--

Comment: The reviewer stated that the scope of AID pesticide activity in host countries is not relevant to impact assessment. The comments specifically addressed the problem of adding to the global load of chlorinated hydrocarbon residues.

Response: It is considered that the degree to which AID contributes to the total use of pesticides internationally is relevant to impact assessment within the context of the total use. The amount of pesticides funded by AID is very small when compared to total world usage. It is essential to understand this to gain perspective in assessing the impacts of the AID pest management programs in less developed countries or the global environment.

Foreign Governments--

The Government of Guyana--

Comment: The reviewer suggested a reorientation of AID's pest management program to preventive integrated pest management techniques, rather than curative measures.

Response: The future AID pest management policies and strategies, as set forth in Chapter VI, represent a strong commitment to the implementation of preventive integrated pest management measures.