AGENCY FOR INTERNATIONAL DEVELOPMENT
BUREAU FOR AFRICA

Office of Sustainable Development
Division of Productive Sector Growth and Environment
Washington, DC 20004

COUNTRY SPECIFIC SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT (SEA)TO THE PROGRAMMATIC ENVIRONMENTAL ASSESSMENT (PEA) FOR THE LOCUST/GRASSHOPPER CONTROL IN AFRICA AND ASIA

Final Action Form

Country: Malawi

Date: September, 1997

Recommendation: A **Negative Determination with Conditions** is recommended based on the requirements specified in 22 CFR 216.3(b)(1). **Conditions** given in this SEA regarding "pesticide management" should be followed to avoid problems caused by the misuse or overuse of pesticides. In addition, the monitoring and evaluation requirements specified in the "environmental and non-target impact" section of this SEA should be used to insure that as little negative impact as possible occur in non-target areas, and that adequate monitoring is conducted to mitigate the potential environmental effects of pesticides.

ACTION TAKEN:

Approved: ___X___

Disapproved:_____

Date: September 19, 1997

_____
Bureau Environmental Officer,
Carl M. Gallegos, AFR/SD/PSGE

File No. 27malaw3.sea (AID/W)

SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT

FOR POTENTIAL USAID ASSISTANCE TO
LOCUST/GRASSHOPPER CONTROL OPERATIONS IN
MALAWI

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
(USAID)

IN COLLABORATION WITH

THE GOVERNMENT OF MALAWI

Lilongwe, Malawi
July 1997

DOCUMENT LOCATION, USAID/Malawi
O:\SSHUMBA\DOCS\SEAMAL.MAL
O:\SSHUMBA\DOCS\APPEND.MAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

This document is a supplement to the Programmatic Environmental Assessment (PEA) concerning USAID assistance in locust/grasshopper (l/g) control programs. This Supplementary Environmental Assessment (SEA) was prepared by a specialist provided by AID/W (AFR/DRC) in collaboration with USAID/Malawi, along with support from the Government of Malawi (GOM). Document preparers and contact persons are listed in Appendix A.

The document has been reviewed by USAID/Malawi, AID/W, and the Government of Malawi. It reflects the best current description of future options for USAID assistance to the Malawi Ministry of Agriculture for l/g management. The document also presents the best available estimates of human health and environmental risks, along with possible mitigating strategies. Mitigation may include training programs covering improved health and environmental protection, as well as support for early survey and spot treatment programs. Encouragement is given for use of alternatives to chemical pesticides, along with prudent and environmentally sound use of pesticides when these materials are necessary. Commitments for any possible future program are contingent on future needs for l/g control, the capabilities of the Department of Agricultural Research and Technical Services and the Department of Agricultural Extension Services in the Ministry of Agriculture (DARTS-DAES/MOA), and on a decision by USAID to provide assistance.

While the document primarily concerns l/g management of population active in the southern region of Malawi, it may also serve to guide control efforts for other pests in other parts of the country, given the gathering of appropriate additional information.

ACRONYMS AND ABBREVIATIONS

AChE	AcetylCholinesterase
ADD	Agricultural Development Division, of which there are 8: BLADD Blantyre ADD KADD Kasungu ADD KRADD Karonga ADD LADD Lilongwe ADD MAADD Machinga ADD MZADD Mzuzu ADD SLADD Salima ADD SVADD Shire Valley ADD
AELGA	Africa Emergency Locust/Grasshopper Assistance Project - USAID/Washington
AID/W	US Agency for International Development, Washington, DC
CFR	US Code of Federal Regulations
DARTS	Department of Agricultural Research and Technical Services, GOM Ministry of Agriculture
DAES	Department of Agricultural Extension Services, GOM Ministry of Agriculture
DRC	Disaster Response Coordinating Staff, Africa Bureau, AID/W
DNPW	Department of National Parks and Wildlife, GOM Ministry of Tourism, National Parks, and Wildlife
EA	Environmental Assessment
EPA	Extension Planning Area
FAO	Food and Agriculture Organization of the United Nations
GIFAP	Groupement International des Associations nationales des Fabricants de Produits Agrochimiques
GOM	Government of Malawi
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit ha hectare
HSA	Health Surveillance Assistant
IGR	Insect growth regulator
IPM	Integrated Pest Management
IRLCO-CSA	International Red Locust Control Organization--Central and Southern Africa
JICA	Japan International Cooperation Agency
km	kilometer
l/g	locusts/grasshoppers
MFFEA	Ministry of Forestry, Fisheries, and Environmental Affairs, GOM
MOA	Ministry of Agriculture, GOM
MOH	Ministry of Health, GOM
NEAP	National Environmental Action Plan
PEA	Programmatic Environmental Assessment
PPS	Plant Protection Services, incorporating elements from both DARTS and DAES, MOA

PSAM	Pesticide Suppliers Association of Malawi
RDP	Rural Development Project
SEA	Supplementary Environmental Assessment
TAMS	TAMS Consultants, Inc., New York, NY/Arlington, VA, USA
UNDP	United Nations Development Programme
USAID/	USAID Mission to Malawi, located in Lilongwe Malawi
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency

1.0 EXECUTIVE SUMMARY

This assessment is a supplement to the Programmatic Environmental Assessment (PEA) for Locust and Grasshopper Control in Africa and Asia. It was developed to provide particular, country-specific details in Malawi in order to allow USAID assistance in Locust and Grasshopper Management. It is therefore a extension of the PEA for Locust and Grasshopper Control and is, as such, an integral part of it.

The information contained in this document is intended for use by USAID/Malawi and the Departments of Agricultural Research and Technical Services (DARTS) and Agricultural Extension Services (DAES) of the Malawi Ministry of Agriculture (MOA) to guide environmentally sound locust and grasshopper management in all regions of the country. Among the acridian species which threaten agriculture in Malawi are the Red Locust (Nomadacris septemfasciata) and the African Migratory Locust (Locusta migratoria migratorioides). Localized activity of the Red Locust occurs relatively often, and some spot treatments are usually required. In recent years, however, migrating swarms of both species have caused problems in Malawi. Breeding areas of the Red Locust are in the southern part of the country, and intervention against these populations was necessary in 1997. In previous years, control had been required for swarms of both species entering the southern part of country from Mozambique.

Recent outbreaks were controlled by teams from the Departments of Agricultural Research and Technical Services (DARTS) and Agricultural Extension Services (DAES) of the Malawi Ministry of Agriculture (MOA) with assistance from the International Red Locust Control Organization - Central and Southern Africa (IRLCO - CSA). MOA teams have the capacity for ground-based control operations under locust population conditions which are not at emergency levels, and there is only limited response capability for outbreak emergencies of short duration or within limited areas.

Much of the discussion in this Supplementary Environmental Assessment (SEA) will be directed towards the two locust species cited above. However, the discussions herein need not be limited to a specific pest or region of the country, provided that consideration is given to the climatic, biological, and environmental diversity of Malawi. Additional relevant information should be added to this SEA as needed, as this is a dynamic, rather than static document. As it is part of the PEA, both documents should be consulted during all planning and operational stages of implementation.

Survey and immediate treatment operations are considered foremost in preventing locust or grasshopper outbreaks. Prevention is the key to reducing crop loss and pest control operation costs. Early season intervention requires considerably less pesticide than late season emergency operations, and therefore has less impact on the environment.

Pesticide management must be a priority in control operation programs. Because misused pesticides affect both the environment and crop production in terms of increased costs, any control program must consider possible consequences carefully. Pesticide container disposal must be conducted so as to eliminate food or water storage in used containers. In this regard, supportive legislation and regulations must be enforced to promote sound management practices.

Training should be part of any USAID assistance program. Pesticide safety and the environmental effects of pesticide use and misuse should be conveyed to MOA personnel and the general public through education and public awareness campaigns. Farmer training and Village Brigades can be an important part of management operations, and should be stressed.

The Malawi DARTS should implement a laboratory analysis program to monitor pesticide formulation quality, environmental residues, and effects on non-target species and the environment. Analysis of blood cholinesterase (AChE) testing in pesticide handlers and applicators is strongly recommended. The level of AChE should be determined prior to pesticide application, and routinely done thereafter.

Environmental awareness is emphasized. Fragile ecological areas need to be protected from pesticides, as the impact can be both dramatic and long-lasting. Buffer zones of at least 2.0-2.5 kilometers surrounding ecologically sensitive areas should be supported in any U.S.-funded control operation. Because of the Malawi's great environmental diversity and the importance of wildlife to Malawi's ecology, this document recommends that U.S.-funded assistance in l/g management promote alternatives to the use of chemical pesticides. Several strategies exist which can allow for substantial l/g control; this SEA recommends that FAO take a lead in this area, because of that organization's considerable experience with such efforts in Africa and Asia.

Monitoring of pesticide effects on non-target species and the environment should be included as an integral part of any pesticide use program. Monitoring results should be used in the

planning and operational phases of future locust control programs to adjust or curtail environmentally damaging operations.

USAID/Malawi's action on GOM requests for assistance should be based on evidence that a strategically-organized response plan has been developed which incorporates the principles of preparedness, mitigation, and safety drawn from this SEA, particularly in those aspects involving pesticide use. Provision of equipment or chemicals should be contingent on availability of adequately-trained and qualified personnel for management operations.

2.0 PURPOSE AND PROCEDURES

2.1 Background

With the major upsurge of the Desert Locust (Schistocerca gregaria) in Africa beginning in late 1986 and lasting into 1989, and extensive grasshopper (numerous species) outbreaks throughout the Sahel from 1986 through 1989, the U.S. government was called upon by concerned African nations to assist with technical expertise and needed materials in the management of these insects. In 1987, the Administrator of the U.S. Agency for International Development declared an emergency waiver of the agency's environmental procedures governing the provision of pesticides. The waiver permitted USAID to provide assistance for procurement and use of pesticides for l/g control without full compliance with the Agency's environmental procedures. The Administrator's waiver expired on August 15, 1989.

With the expiration of the Administrator's waiver, any subsequent USAID assistance in procurement and use of pesticides must fully comply with the Agency's environmental procedures. In 1989, a Programmatic Environmental Assessment (PEA) was completed. The PEA, and the country-specific Supplementary Environmental Assessments (SEAs) will serve as the basis for these regulatory procedures. The SEAs contain specific environmental information for each country involved, and provide guidance on environmentally sound management procedures. SEAs have been completed for most of the Sahelian countries and many countries in the southern part of the continent.

Given the periodic nature of locust outbreaks, and the cyclic population fluctuations of grasshoppers, control campaigns for these insects are likely to continue indefinitely. Locusts and grasshoppers are part of the ecology of the African continent, and will readily take advantage of agricultural crops. Control measures must manage problematic insects at economically reasonable levels in regard to crop loss, rather than try to achieve extermination. In recent years, Malawi Plant Protection Services (PPS) has found itself involved routinely in at least limited control of locusts and grasshoppers; and in 1997 intensive intervention was required against swarms of Red Locusts and outbreak populations of Green Grasshoppers. In light of this recent trend in l/g activity, it becomes critical to both USAID/Malawi and to PPS that an SEA is in place, should assistance in l/g control be required. A goal of any U.S.-funded

assistance in l/g management should be sustainability of operations by the Malawi MOA.

Because of both the periodic and cyclic abundance of locusts and grasshoppers, and their potential impact upon food supplies, it is likely that requests for USAID technical assistance, aerial application services, commodities, equipment and/or insecticides will continue. While it is likely that most of these requests will be related to the use of chemicals for control operations, it is important that USAID take the lead in investigating and providing alternatives to chemicals which have a potential negative environmental impact. Should USAID/Malawi choose to provide chemical pesticides, the Environmental Procedures in Regulation 16 (22 CFR 216) must be followed. Along with the PEA, this document fulfills the requirements necessary to allow USAID to provide assistance to Malawi. Because locust control operations would most likely be concentrated in the southern parts of the country, this SEA emphasizes, but does not restrict itself to, those parts of Malawi.

2.2 Drafting Procedures

USAID Environmental Procedures (22 CFR 216.3(a)(4), describes the process to be used in preparing an Environmental Assessment. The rationale and approach for the country-specific SEA are outlined in cables 89 State 258416 (12 Aug. 1989) and 89 State 275775 (28 Aug. 1989).

This draft SEA for the country of Malawi was produced in July, 1997, by AID/W (AFR/DRC) contractor David Evans with assistance from Stephen E. C. Shumba, Agricultural Specialist, USAID/Malawi. Assistance in the form of contacts within the Malawi government was provided by Defrea V. Kampani, Director of Agricultural Extension Services, Ministry of Agriculture.

Interviews were held with representatives of Malawi government agencies, NGOs, other donor governments, FAO, and UNDP.

2.3 Previous Assessments

The previous assessment concerning this subject, and the primary supportive document, is the **Programmatic Environmental Assessment (PEA) for Locust and Grasshopper Control in**

Africa/Asia (TAMS/CICP, 1989). The PEA covers grasshopper and locust control operations in Africa and Asia. This SEA is a supplement to the PEA, and should be considered an integral part of the PEA: it concerns the country-specific environmental issues not addressed in the PEA.

Other assessments regarding locusts or grasshoppers include:

(1) **The Africa Emergency Locust/Grasshopper Assistance Mid-term Evaluation. (with specific-country case studies for Chad, Mali, Niger, Mauritania, and Cape Verde)** (Appleby, Settle & Showler, 1989);

(2) **Final Report on the Handling of Pesticide in Anglophone West Africa.** (Youdeowei, 1989, FAO Conference report, Accra , Ghana);

(3) **Final Report on Pesticide Management in Francophone West Africa.** (Alomenu, 1989, Report to the FAO Conference at Accra, Ghana);

(4) **Draft Environmental Assessment of the Tunisia Locust Control Campaign.** (Potter et al, 1988);

(5) **Supplementary Environmental Assessments** for the countries of Botswana, Burkina Faso, Cameroon, Chad, Eritrea, Ethiopia, The Gambia, Kenya, Madagascar, Mali, Mauritania, Mozambique, Niger, Senegal, Somalia, Sudan, and Tanzania.

These documents have been used freely in the preparation of this assessment and are often relied on without citation. Internal USAID/Malawi data are used without citation. Other relevant documents are cited in the text when supportive data are used.

In addition to the above locust-specific documents, there are other documents which concentrate on pest management and agricultural issues or environmental and biological aspects of Malawi. Agricultural production and pest information is found in Ministry of Agriculture: **Guide to Agricultural Production in Malawi 1993-1994**. Country-wide regional comparisons of food crop production are presented in the Ministry of Economic Planning and Development: **Food Security and Nutrition Bulletin. 1995**. Ministry of Economic Planning and Development: **Economic Report. 1997** provides current information on changing agricultural trends as well as prognoses for development of

tourism in Malawi. Department of Research and Environmental Affairs: **Malawi National Environmental Action Plan. Volume 1: The Action Plan. 1994** and **National Environmental Policy. 1996** summarize environmental conditions in Malawi and government environmental policies. These documents are fully cited in the Reference section 5.0, and should be consulted for further information.

2.4 Environmental Procedures.

It is USAID policy to ensure that any negative environmental consequences of an USAID-financed activity can be identified and mitigated to the fullest extent possible prior to a final funding and implementation decision. This document covers specific environmental consequences involved with chemical pesticide use, and necessary safeguards and mitigation for any future control programs. In addition, alternatives to chemical pesticide use are highly recommended when appropriate, and considered to be part of an overall integrated pest management (IPM) program.

Although Malawi does not have procedures precisely equivalent to the National Environmental Policy Act (NEPA) or USAID Environmental Procedures, it does have sets of regulations governing the substance of such programs. These are covered in the following section. USAID Environmental Regulations and Procedures are likely to be controlling for the present because they are more comprehensive and more applicable to USAID programs and projects.

2.5 Malawi Environmental Procedures.

2.5.1 Malawi Pesticide Regulations.

To facilitate proper and safe use of pesticides, regulations are necessary which cover importation of pesticides, distribution to agricultural areas, actual use of the pesticide, and disposal of unwanted pesticide and used containers. Legislation on pesticide use, importation, management, registration, and impact monitoring is in draft form (Section 40, Act No. 23); and approval by Parliament is expected during 1997. This proposed Pesticide Act is based on the **FAO International Code of Conduct for Distribution and Utilization of Pesticides.** Pesticide imports, distribution, quality assurance, and labeling have been

virtually unregulated for the past several years. Upon Malawi's recent democratization with its ensuing trade liberalization, previous import restrictions have been greatly relaxed, and much pesticide enters without restrictions on use, storage, or labeling. Much of this material is readily available on the street.

Given the current climate of lack of regulation, adoption of formal legislation will considerably enhance agricultural, environmental, and public health policies in Malawi. The Pesticide Suppliers Association of Malawi (PSAM) is a private sector group formed in the late 1980s in response to GOM's plans to institute regulations. Now it constitutes a self-regulating body with its own code of conduct (based on FAO standards). Once pesticide legislation is instituted, group members hope to be able to assist one another in complying with GOM regulations.

This SEA commends GOM for proceeding with potentially effective pesticide legislation, and supports placing high priority on instituting enforcement procedures. Enforcement of pesticide legislation will require personnel who have received adequate training in pesticide use, recognition, and labeling.

A U.S. pesticide contribution to Malawi, or a U.S.-funded pesticide purchase in Malawi, will be controlled not only by applicable Malawi laws and regulations, but also by U.S. pesticide regulations and procedures, as described in the PEA. In this regard, only those pesticides listed in the PEA, or amendments thereof, are acceptable unless this SEA is amended to cover possible environmental impact which may result from use of that particular pesticide. Pesticides used in a U.S. operation are to be used according to label instructions only. Used pesticide containers and any unwanted pesticide resulting from a U.S.-funded operation must be disposed of properly and safely. No U.S. funds shall be used to purchase, transport, or apply any pesticide that has been banned in the United States. This especially includes chlorinated hydrocarbons such as dieldrin and lindane.

2.5.2 Other Environmental Regulations in Malawi.

Although responsibility for environmental protection is divided among several different Ministries in Malawi, environmental policy is overseen by the Department of Environmental Affairs in the Ministry of Forestry, Fisheries, and Environmental Affairs (MFFEA). The decision-making body within the Department is the National Council for the Environment, which

is also responsible for enforcement. This National Council is supported by a Technical Committee on the Environment, which has directors for specific areas, e.g. forestry, natural resources, on subcommittees. Specific subcommittees have been designated for wetlands and biodiversity. The National Council instructs the Technical Committee to assess specific issues and report back to the Council, which can then proceed with enforcement.

Recent restructuring of the GOM, along with the fact that environmental concerns fall under different authorities, has caused blurring of responsibilities, overlaps, conflicts, and difficulties in enforcement. Some laws are not strictly enforced simply because of lack of institutional support and adequately trained personnel.

In 1994, as a signatory to Agenda 21 of the United Nations Conference on Environment and Development, GOM produced a National Environmental Action Plan (NEAP). The goal of the NEAP is to provide a framework for integrating environment in the overall socioeconomic development of the country. GOM published its NEAP-based National Environmental Policy in 1996. A draft act based on the NEAP (Act No. 23), deals with such cross-sectoral issues as overall environmental policy formulation, environmental planning, environmental quality criteria and standards, environmental impact assessment, pollution, institutional coordination and conflict resolution, and monitoring of implementation of environmental policies by sectoral agencies. FAO international standards are used in much of the proposed legislation, but these are being revised to be specific to Malawi. Passage of Act No. 23 by Parliament is anticipated for 1997.

The proposed legislation appears adequate, and Act No. 23 will greatly improve the coordination of environmental policy in Malawi. A notable feature of this act is the formalization of the need for presentation of Environmental Impact Assessments along with project proposals which have environmental implications. Act No. 23 is far-reaching in its scope and codifies a number of issues which have not been regulated for the past several years. One of the major future tasks for the Department of Environmental Affairs is public education on environmental issues. The Department is commended for publishing its **Administrative Guidelines for Environmental Impact Assessment** in January 1997.

The organization responsible for managing Malawi's park and reserve system is the Department of National Parks and Wildlife (DNPW) in the Ministry of Tourism, National Parks, and Wildlife.

Parks and reserves occupy 11.6% of Malawi's total land area. A major role of DNPW is that of coordinating all matters concerning wildlife and national parks. DNPW's objectives include conservation and management of the natural environments of Malawi and their flora and fauna. Parks and reserves are protected under Part VII (Environmental Management) of Act No. 23: Sections 32(Environmental protection areas), 33 (Environmental protection orders), 34 (Enforcement of environmental protection orders), 35 (Conservation of biological diversity, and 36 (Access to genetic resources).

Any USAID funded programs involving pesticide use for locust or grasshopper control should follow Malawi regulations concerning the protection of designated areas. In that regard, this SEA supports the GOM commitment to protect the natural environment, and adopts any conditions to be mandated by GOM limiting the use of pesticides, and also concurs in any designated zones that are protected from pesticide use.

3.0 PROJECT DESCRIPTION

3.1 Malawi Environmental Profile

Malawi lies in the southern half of Africa between latitudes $9^{N}22'$ and $17^{N}7'S$ and between longitudes $32^{N}40'$ and $35^{N}55'E$. Its north-south length is about 900 km and its width varies between 80 and 160 km. The total area is 118,483 km^2 -- about the size of Pennsylvania. It is a landlocked country, bordered by Tanzania to the north, Mozambique to the east, south, and west; and Zambia to the west. The geography of the country is dominated by Lake Malawi, the third largest lake in Africa and the eleventh largest in the world. The lake extends 568 km along the length of the country and varies between 15 and 80 km wide. Malawi contains some of the world's most important wetland xecosystems, including the shoreline plains of Lakes Malawi, Chiuta, and Chilwa, and the marshes of the Shire River system.

Lake Malawi and the Shire River are part of the Great African Rift Valley system. On either side of the rift abrupt escarpments rise to highlands. The west highlands include the Nyika, Viphya, and Dedza plateaus. The highlands in the east include the Shire highlands, Zomba plateau, and the Mangochi and Namizimu hills. The eastern highlands continue northwards into Mozambique, and eventually into Tanzania. Behind the rift edge highlands the land descends gently to the Central African Plateau

at elevations around 1000 m. The Lilongwe and Kasungu plains are representative of this topography. The lowest elevation of about 37 m is on the Rift Valley floor at the extreme south, and the highest point is Mulanje Mountain (3050 m), an ancient volcanic plug standing on the plateau to the southeast, and the highest point in central Africa.

Malawi's climate is greatly influenced by the lake and by elevation. In essence there are three seasons: cool and dry from May to August, warm and dry from September to November, and warm and wet from December to April. The annual rainfall ranges from 600 to 1800 mm, and is generally greatest at higher elevations, and least in the Lower Shire Valley and the Chitipa plain. Highest temperatures are in the Rift Valley where they may approach 40^{N}C during October and November. In cooler months, frost is quite common on the higher plateaus.

Predominant vegetation of Malawi is the savanna woodland, adapted to the five-month dry season. Evergreen forests are found in river valleys or mountainous regions where water is plentiful. Grasslands are found on high plateaus.

Malawi's population of about 10.3 million, growth rate of 2.9% per year, and limited land resources combine to make it one of the most densely populated countries in sub-Saharan Africa relative to the amount of arable land available. About 90% of the population is rural and dependent on agriculture, which employs almost 85% of the labor force. The country depends on increased production to support its growing population, and there will likely be an increased dependency on pesticides in order to optimize yields.

Current environmental issues of importance are also population-related: land degradation; deforestation; water pollution from agricultural runoff, sewage, and industrial waste; and siltation of fish spawning grounds.

3.2 Agricultural Resources

Although rainfall varies, most parts of the country receive sufficient rain for dryland farming (except during drought periods, as in recent years). The wide range in climate enables Malawi to grow both tropical and sub-tropical crops. Most cash crops arise from the estate sector, with the major ones being tobacco, tea, coffee, and sugar (Table 1). The smallholder sector, which accounts for roughly 90% of the total population,

Table 1. Exports by Main Commodities, 1993-97
(% share of total value)
(GOM. Economic Report. 1997)

Table 2. Smallholder Crop Estimates for Major Crops, 1992-96
(GOM. Economic Report. 1997)

Figure 1. Maize Production per Agricultural Development Division (GOM. Food Security and Nutrition Bulletin. 1996)

Figure 2. Production of Other Food Crops, 1992-96
(GOM. Food Security and Nutrition Bulletin. 1996)

depends on maize for its staple food and as a source of cash income in most parts of the country. Lilongwe and Kasungu Agricultural Development Divisions are the major maize-producing areas, contributing about half the country's entire maize output (Fig. 1). Important secondary crops in various areas are millet, sorghum, rice, bananas, groundnuts, and beans/pulses. These food crops also serve as important sources of cash income. Tobacco and cotton are important income sources within the smallholder sector.

The country's food and agricultural problems have been intensified by three serious droughts in the past four years. Since the first major drought in 1991-92, growers have been encouraged to diversify agriculture with drought-resistant root crops. In this time, the area planted to cassava has increased by 81%, and that planted to sweet potato has increased by 240% (Fig. 2). These crops have now entered the cash market, especially in poorer urban areas. Production of sorghum and millet has also increased steadily (Table 2).

3.3 Agricultural Pests

3.3.1 Locusts and Grasshoppers

The insects considered in this document are locusts and grasshoppers. The locust pest species of greatest importance in Malawi is the Red Locust (Nomadacris septemfasciata). Swarms of the African Migratory Locust (Locusta migratorioides) have also caused serious damage in the country. In addition, there are a number of grasshopper species which can become pests depending on environmental conditions. The most damaging is the Green Grasshopper (Homorocoriphus nitidulus vicinus) which can occur in population concentrations throughout the entire agricultural region and has been particularly important in the north and the south as a pest of rice and countrywide on sorghum and millet.

The two locust species are characterized by migrating gregarious swarms, yet they are ecologically distinct:

Red Locusts breed in the wetland plains surrounding Lake Chilwa and in the lower Shire River valley, in the southern region of the country. Vwaza Marsh, in the north, is a possible breeding area. From these breeding areas, swarms then have access to the entire country (Fig. 3). It is potentially the most important pest species in Malawi

because of the extensive damage it can cause within a short period of time. Fortunately the breeding areas are known, so that monitoring can be done effectively. Red Locust swarms also move into Malawi from Mozambique, where control in breeding areas has been problematic. Migratory swarms can occur as late as November (during maize planting), although the main season of swarm activity is April-June, with monitoring and control in breeding areas beginning in January.

African Migratory Locusts breed in semi-desert conditions and are less geographically restricted by suitable breeding areas than Red Locusts. Breeding does not occur in Malawi, and swarms historically have crossed into the southern region of the country from Mozambique. The season of activity is October through April.

Some localized activity of Red Locust occurs every year, and spot treatments are frequently required. Wide-ranging infestations of both species are more sporadic. Grasshoppers will be found in Malawi at varying levels of infestation every year. Agricultural Development Division (ADD) field personnel can make decisions on spot treatment of locusts and grasshoppers.

3.3.2 Other Pests

Areas which are vulnerable to l/g attack are also threatened by other pests of concern to growers and PPS. MOA's assessment of the rank order of importance of the country's agricultural pests is:

1) Red Locust

2) African Armyworm (Spodoptera exempta) is very destructive to maize, rice, wheat, sorghum, and millet. It has become an endemic pest: it causes losses every year, and the attack can be sudden. A major attack occurred in the Nov.-Jan. growing season, 1993-94, with a secondary attack in the July "showers season." Populations are monitored country-wide, although use of pheromone traps has been discontinued.

3) Larger Grain Borer (Prostephanus truncatus) causes close to 50% after-harvest loss on stored grains. It came into the country from the north, but is now distributed throughout Malawi.

4) Armored Cricket (Acanthoplus spp.) frequently causes damage to the maize crop and is often active at the same time as the Red Locust.

5) Quelea (Quelea quelea) is regarded as an important pest of sorghum, millet, and rice.

6) Tobacco Beetle (Lasioderma serricorne) is emerging as an important stored product pest of the major cash crop in Malawi.

3.4 Locust Management - Overview

3.4.1 Past Locust Campaigns

The two locust species discussed in this document are normal parts of the biological system in Central and Southern Africa. Periodic upsurges and migrations occurred even before the introduction of extensive agriculture. With the introduction of agriculture, however, these insects, along with other species that are considered "pests," could readily take advantage of crop lands in the path of the migrations.

Red Locust control may be required nearly annually in the southern Malawi breeding areas. Limited operational assistance in Red Locust control has been available from the International Red Locust Control Organization - Central and Southern Africa (IRLCO-CSA). IRLCO-CSA is an Africa Development Bank-funded regional locust control organization; there are nine member countries: Botswana, Malawi, Kenya, Mozambique, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe. Two aircraft and a helicopter are available, as is survey and forecasting information (APPENDIX D).

In May of 1997, six Red Locust swarms and one concentration in the Lake Chilwa plains were controlled by fixed wing aircraft from IRLCO-CSA, using Fenitrothion 96%. Ground control had previously been carried out by PPS against hopper bands in the Lake Chilwa Plains. IRLCO-CSA carried out aerial operations against both Red Locust and Armored Cricket in the previous season. In October 1996, MOA contracted with a private aerial control service for operations in the breeding areas because of unavailability of IRLCO-CSA aircraft (APPENDIX D and E).

African Migratory Locust outbreaks occur occasionally from breeding areas outside of Malawi. A 1993 outbreak in the Shire

Figure 3. Red Locust Breeding Areas, Malawi

Valley Agricultural Development District (SVADD) was controlled using Fenitrothion 96% for aerial treatment and 50EC for ground spraying. Aerial spraying was conducted by IRLCO-CSA assisted by Malawi PPS. Ground spraying was done by the Department of Agricultural Extension Services (DAES).

The recent outbreaks were controlled by MOA teams operating in the affected areas, with assistance by IRLCO-CSA. Because of financial constraints in recent years, chemicals used (and frequently aviation fuel) were supplied by MOA. During the locust management programs, equipment and chemicals were kept at Bvumbwe Agricultural Research Station and at ADD offices in the areas of the country affected. Chemicals for the campaign were not stored in the field for long periods, but were distributed from DARTS Agricultural Research Station at Chitedze in operational quantities. Most quantities remaining at the end of the campaign were returned to Chitedze and Bvumbwe.

3.4.2 Crop Loss Assessment

In considering locust damage to agriculture, there is a basic assumption that these insects cause significant crop loss and therefore must be controlled. The amount of crop yield that is lost due to an infestation of these insects is a particularly important parameter, and should be determined as soon as possible to assist in the decision as to both the level of funding needed, and the amount of pesticide to be discharged into the environment. Crop loss information is therefore needed to guide both the Malawi MOA and USAID (as well as other donors) in the level of response which may be needed. Once infestation levels can be related to yield loss, management operations can be more realistic in determining the level of effort needed.

In addition to national aggregate crop losses, consideration also needs to be given to the social and economic costs of grain distribution even when losses to individual farmers or villages may be small. Even if the overall crop loss is low, some localized areas may experience high losses. Costs of grain transport over long distances may be more prohibitively expensive than those of a locust/grasshopper control program. Losses in grasslands are more difficult to assess than in crop lands, because impacts are on wandering grazing animals, and thus somewhat indirect.

Crop losses can vary geographically, with extreme damage occurring near areas which seem untouched. Regional information on crop productivity, l/g infestation levels, and efficacy of

control efforts needs to be compiled and analyzed over a period of years in order to obtain more precise estimates of locust management program cost effectiveness. This SEA strongly urges that such data collection and analysis be undertaken.

3.4.3 Predictability/Breadth of Operations

Locust infestations are difficult to predict in advance. Rainfall distribution is influential, but locusts often occur in patterns not easily related to any obvious environmental determinant. Because of this unpredictability, surveillance is essential for designing tactics to maintain low locust populations and prevent outbreaks. As rainfall and the vegetation that follows it are important factors, remote sensing techniques and satellite-derived Greenness Maps may be useful as additional guidance to supplement field surveillance.

Field survey is essential in locust management programs, and must be given high priority by both MOA departments and assisting donors. Included in the survey program must be a sound knowledge of pest biology and an understanding of the impact of environmental conditions. Survey results need to be relayed to DARTS in Lilongwe in a timely manner, in order to allow administrators time to direct logistical operations and obtain needed materials (APPENDIX C).

Although some survey and operational assistance may be available from IRLCO-CSA, the organizations responsible for major control activities are MOA's DARTS and DAES. Although these personnel have some of the expertise needed for a responsible management campaign, additional training programs should be considered. DARTS is responsible for planning, survey, operational control and campaign assessment, and DAES personnel must be trained to use pesticides in a safe and environmentally sound manner.

In instances of a locust emergency, the MOA should be encouraged to work closely with IRLCO-CSA and the donor community to insure that duplication of unneeded material or pesticide donations and excess stock buildup do not occur.

3.4.4 Level of Infestation

Grasshoppers and locusts vary over a range of population levels in their natural habitat, depending upon rainfall and other environmental conditions. A migrating infestation of

locusts, depending upon wind conditions and movement patterns, can have a significant impact on agriculture. For grasshoppers, crop infestation levels depend upon the numeric density and life stage of the insect. In Malawi, grasshoppers may be a problem in some regions every year. Locusts, however, are widely periodic and can fluctuate greatly over time periods of five to ten years, if not longer.

For management planning purposes, impact on ultimate crop yield has been divided into four infestation levels. Note that these levels are quantified in relation to the intervention threshold level. The intervention threshold (also called economic threshold) is very specific to the crop, life stage of crop, insect species, and insect life stage. This concept is discussed in more detail in section 3.5.5 of this document.

Level 0 describes a "normal" density of locusts or grasshoppers. In this regard, locust and grasshopper density levels will be below the intervention threshold level for a given species. Crop losses from this level of infestation are minor and localized. The PPS is capable of carrying out any needed treatment programs without donor assistance.

Level I describes a situation with locust or grasshopper populations at levels which will require additional donor assistance to avoid crop loss. In this case, pest densities will be at or slightly above intervention threshold levels. The PPS may need assistance to cover additional costs, including materials and equipment needed to reduce population levels.

Level II describes high locust or grasshopper densities with large numbers in both crops and pasture lands. Here, l/g densities will exceed the intervention threshold level. The capacity for PPS management will likely be exceeded. Significant crop loss is probable without additional donor assistance and intervention.

Level III describes a situation involving very high locust or grasshopper populations extending over a large area. Again, densities exceed the intervention threshold. This situation will require considerable donor assistance and intervention to avoid l/g outbreaks and substantial crop loss.

Because of the complex effects of crop loss, investments by donors at each of the four intervention levels may be justified. At each level, assistance which builds sustainable infrastructure would be most appropriate.

3.4.5 Thresholds of USAID Assistance

The MOA is expected to maintain an ongoing insect management program during periods of normal pest levels. This program should include efforts to reduce human health risk, protect environmentally sensitive habitats, and minimize pesticide use through use of cultural, biological and traditional means of control. In decisions on assistance to the MOA for locust or grasshopper management activities, USAID/Malawi will examine both the pest situation and the capabilities of the MOA. Decisions will be made in such a way as to minimize the amount of pesticide used.

If USAID/Malawi does choose to participate in an assistance program, it is important that support be coordinated with other donors and the GOM to achieve a reasonable and balanced program. Assistance for such a program should emphasize the principles of Integrated Pest Management (IPM) (as discussed in section 3.5.5), in that all available management resources should be considered. While probable crop loss will be a criterion for USAID/Malawi involvement in control efforts, sustainable infrastructure development and cost/benefit ratio will also be considered. Participation by USAID/Malawi in emergency operations will be carefully tempered with an examination of what long-term benefits will be achieved in addition to an insect population decrease. Because use of pesticides in Malawi has been increasing over the last few years, USAID/Malawi will assist primarily with a program emphasizing effective survey procedures and use of non-chemical control methods.

The level of USAID/Malawi participation in a l/g management program should not only be related to the extent and severity of the problem, but also to the extent such assistance will yield greater sustainability of MOA programs. The actual level of intervention assistance will depend upon a number of variables, including insect density, crop conditions, MOA response capability, environmental conditions, and the potential for a major outbreak. It is highly recommended that USAID/Malawi request technical assistance from AID/W or IRLCO-CSA in making these determinations.

Prior to implementation of l/g assistance, a thorough analysis of needs is necessary. In evaluating areas of assistance, USAID/Malawi should be responsive not only to requests of the GOM, but must further ascertain what materials the PPS and IRLCO-CSA already have, and what other donor-supported programs are planned or implemented. Supplying PPS with an overburden of pesticides, unneeded materials, or poorly

planned training will not assist in managing locusts or grasshoppers. In addition, an independent verification of pest identity, density, and potential impact should be made by a qualified technician prior to fund committal and allocation. In this latter regard, USAID/Malawi might request assistance from AID/W or IRLCO-CSA.

3.4.6 Disaster Level of USAID Participation

Should a substantial and extensive locust or grasshopper outbreak occur in Malawi, a large scale operation may be needed as a last resort to protect crops and reduce pest population levels. At such a level of intervention, risks to humans and the environment will be high, but the alternative of substantial crop loss may make intervention unavoidable.

In a situation calling for large-scale intervention, all possible safeguards must be instituted, with control operational decisions built on the following hierarchy: 1) crop protection, 2) environmental protection, and 3) pest population reduction. This ordering places the highest priority on crop protection, and the lowest on reducing pest populations (where the focus is on future generations of a pest species, population reduction of the present generation has not proven effective).

During large-scale operations, there is likely to be an increase in accidents, pesticide overuse, and application of incorrect formulations. The phenomenon is due primarily to the much greater use of pesticides and the pressure of panic treatments at these times. The most important function of the GOM under these conditions is to institute greater local control (for example, use of Village Brigades), and to communicate effectively with the affected population. GOM will need to describe the necessity of the emergency measures, and ensure to the extent possible the safety of the population and the environment. Operations at a local level, accompanied by appropriate training in pesticide use and safety, is greatly preferred to massive treatments by large aircraft.

The position of USAID/Malawi is to support the judicious use of such chemicals for the control of food crop-threatening pests. The first line of defense must be field survey work to monitor the population level of a particular pest. Proper monitoring will generally allow sufficient time to plan a strategy of control. Survey operations will also alert officials should pests be breeding at a faster rate than expected, or if a significant migration has occurred. The second line of defense

is spot treatment via ground applications. This strategy involves personnel-intensive measures to directly attack sites of the infestation at early stages of the insect life cycle. Aerial application is considered a last resort. This control measure is used when all others have proved ineffective or when the magnitude of the threat exceeds the response capacity of MOA through ground control operations.

3.5 Locust Management - Operations

3.5.1 MOA Crop Protection

Crop protection responsibility falls within two Departments within MOA: Agricultural Extension Services (DAES) and Agricultural Research and Technical Services (DARTS). Pesticide and equipment recommendations are made by DARTS, and survey and operations are the responsibility of DAES. DARTS and DAES are capable of carrying out insect management and crop protection activities when locust or grasshopper population levels are low (levels 0 or 1, section 3.4.4). It may be appropriate to provide assistance programs to the MOA at this level, particularly in the form of training, the goals of any such assistance being to increase sustainability of the MOA infrastructure. Although action plans may be developed annually by DARTS, material and equipment allocations are below those needed to control substantial numbers of swarming locusts. With vigilant survey and management programs, locusts and grasshoppers can be maintained at low population levels.

Active survey and early season management can save valuable funds and resources over the long-term, compared with costs of short-term emergency operations. IRLCO-CSA has been a valuable resource for survey information and early intervention in this regard. However, additional donor assistance may be required if l/g infestation levels exceed the capacity of PPS. Concerning U.S.-funded assistance involving pesticides, the information, recommendations, and regulations discussed in this SEA and the PEA must be observed and reckoned within project design and implementation.

Ideally, by developing a strong base of trained personnel and a well-maintained fleet of vehicles and equipment, the MOA will be able to hold impending grasshopper outbreaks, and invading locust swarms to a minimum. This will result in considerably less pesticide being used than if these pests are allowed to reach high population levels. In this regard, it is especially important to involve villagers and farmers living in

invasion areas in early season control endeavors. These types of efforts, combined with improved legislation and regulations, will greatly lessen potential negative environmental effects of pesticide use. Any assistance USAID can offer to build such an institution, with full participation and involvement of the relevant Malawi MOA departments, will be a far more effective investment than the immense amounts which have been spent on past emergency operations (with little effect on sustainable infrastructure).

3.5.2 Survey and Control Preparations

In order to keep locust and grasshopper population numbers below levels where crop loss is imminent, and reduce the environmental impact of pesticide use, it is important to survey early in the season, and to implement control activities immediately. Trained personnel, and equipment in full working order are required to do this. The main elements to be included in locust or grasshopper survey programs are:

- Full knowledge of the physical and temporal distribution of the pest species.

- Monitoring of environmental conditions and changes which might lead to increased numbers of pest species. This will require an adequate knowledge of pest species biology, the status of environmental conditions, and how these conditions can be augmenting or limiting factors.

- A vulnerability assessment in terms of crops threatened by the pest species, including relative importance of crops, and the crop stage of development, and an understanding of the vulnerability of the human population likely to be affected.

- The availability of pest management support resources to be mobilized for control: pesticides, application equipment, as well as logistical and technical support.

Survey and monitoring personnel in Malawi include DAES and DARTS staff, other government workers, and local farmers. Administratively, Malawi is divided into 3 regions: Northern, Central, and Southern. Regional DARTS Research Stations are located at Lunyangwa (Northern), Chitedze (Central), and Bvumbwe (Southern). The stations act as pesticide collection, storage, and distribution centers, and each station has a Plant Protection Supervisor who coordinates operations in the event of a large outbreak. The Supervisor is responsible for distributing

applicator safety information, insecticide poisoning treatment kits, and information on equipment operation and maintenance to Crops Officers and Mechanical Officers at ADDs. DAES personnel from Lilongwe train plant protection personnel at the ADD level. A formal applicator and safety training program is not now in place, although an attempt to develop a "Train-the-Trainers" operation had been made several years in the past. Operations against an outbreak from Red Locust breeding areas in Malawi would be centered around the DARTS Research Station at Bvumbwe but coordinated by DAES in Lilongwe.

Malawi is also divided into 8 Agricultural Development Divisions (ADDs): two in the Northern Region, three in the Central Region, and three in the Southern Region (Fig. 4). A main ADD administrative office is located in each. Some basic stocks of application equipment, a yearly quota of 150-200 liters chemicals for spot treatments, and 80-100 sets of protective gear are kept at ADD offices. Chemicals stocked at ADDs more than two years are to be returned to the Central DARTS Research Station at Chitedze. (In reality chemicals are transferred from one ADD to another, a procedure with which DARTS concurs so long as quantities are accounted for. Protective clothing procured by the MOA is of the heavy type, and not optimal for field conditions in Malawi.)

The ADDs are subdivided into Rural Development Projects (RDPs) which in most cases have their agricultural administrative boundaries coinciding with district administrative boundaries. In total there are roughly 30 RDPs covering all smallholder farmers in the country, with future plans for a total of 40.

ADD and RDP offices are linked with a telephone network, though communication with some critical areas, e.g. Bvumbwe, is difficult. The ADD Officers are responsible for monitoring insect populations and reporting to DARTS in Lilongwe. Monitoring of Red Locust breeding areas is ideally done once a month, and every two weeks during the activity season. RDPs are further divided into a total of 184 Extension Planning Areas (EPAs) and finally into blocks. Personnel in the EPAs and RDPs act as the monitoring and control team for that Area or Project, receiving information directly from farmers on locust sightings or even availability in local markets. Some monitoring in the Shire River Valley is done by Sucoma Sugar Company personnel. Each EPA is headed by a Development Officer, and supported by a team of up to 10 Technical Assistants. Extension Area personnel are regarded as the "frontline staff," who provide training on pesticide use and safety to the farmer. Small stocks of pesticides, application equipment, and 5 sets of protective gear

are kept at the EPA level for immediate response, particularly for armyworm control.

Prior to main periods of vulnerability (Sept.-Oct.), DARTS should continue to ensure that District Offices in the south of Malawi are equipped and prepared to face a low level (level 0 in section 3.4.4) of l/g management. Adequate preparation would include: a working radio system, operating vehicles and application equipment, protective clothing and safety equipment that are clean and ready to use, and the needed amount of pesticides carefully stored and ready for use.

3.5.3 Village Brigades

Farmers can play a major role in a control campaign -- reporting population levels to actively protecting crops from nymphal/hopperband infestations. They can also serve as a means for implementing alternative forms of pest management. With chemical control, farmer and village training programs are required. Both USAID and FAO have used the Village Brigade technique since 1987 in areas of Africa where locust or grasshopper infestations are endemic. The technique may be applicable to the situation in Malawi for locusts as well as other insect pests.

Each Village Brigade typically includes 10 interested and enthusiastic villagers. Participants receive 3 days of intensive training (covering identification and biology of both local pest and beneficial insect species, fundamentals of good survey techniques, and safe handling and use of pesticides); and are then given a small quantity of pesticide, a set of protective clothing, and necessary application equipment. Village Brigade members are responsible for locust or grasshopper control at the village level and would be supported by DAES.

There are limitations to the technique: it can lead to the assumption by affected populations that all intervention will be pesticide-based, and it can become an operation which requires continuing subsidization.

Support by DAES is essential for a Village Brigade. Once a Brigade is formed, members must receive needed materials and technical support within a reasonable time frame in order to achieve crop protection. While a trained group may in theory be able to creatively protect crops against pests without resources; in reality, they will lose both enthusiasm and expertise without support.

3.5.4 Ground and Aerial Operations

Use of spray aircraft should be considered a last resort in a U.S.-funded locust or grasshopper management program. With an attentive survey program, combined with a rapid deployment of ground pesticide application teams, it is possible to conduct an effective management campaign without spray aircraft. USAID fully supports this concept, and the needed training programs for survey and ground teams. In addition to the basics of survey techniques, pesticide safety, and application; such training must encompass a thorough background knowledge of pest species that require control.

While aircraft can be effective management tools, and may be justifiably needed during locust or grasshopper outbreaks, they should be used with caution. This is because: 1) aircraft carry and spray larger quantities of pesticide than ground equipment, and therefore are more likely to have a negative environmental impact; 2) they are expensive to run and maintain, and are unlikely to be sustainable without a high level of outside input; 3) assumed use or support by donors could result in less attention by DAES and DARTS to maintenance of an effective survey and ground control system. Large multi-engine aircraft should not be used for aerial spray purposes, and helicopters may be used under very critical conditions, e.g., precision application situations or inaccessible/rugged topography.

The Malawi PPS can request assistance in aerial control from IRLCO-CSA for outbreaks from the breeding areas, but swarms entering the country from the outside are the control responsibility of GOM PPS. Aircraft from IRLCO-CSA are often in demand for control operations over a wide range of southern Africa, and may be difficult to have on site at the appropriate time. DAES made an attempt in October 1996 at pest management using privately hired aircraft. Control was achieved but at considerable financial expense. The fact that the control firm had little experience with pest management operations in the southern wetland breeding areas also raises the possibility of environmental damage.

During aerial control operations in the Lake Chilwa area, aircraft are usually based either at the military airstrip at Zomba or airstrips at Mangochi or Liwonde. Shire River operations are based at the Sucoma Sugar Company airstrip.

Aerial control operations for locusts have produced the following generalizations:

Figure 4. Malawi Agricultural Development Divisions (ADDs) and DARTS Regional Agricultural Research Stations

- large infested areas can be treated in a short time;
- inaccessible areas are more easily treated;
- aircraft logistical support is expensive, and large amounts of pesticides are required;
- pesticide drift is difficult to control;
- landing strips for fixed-wing aircraft require frequent and expensive maintenance.

In light of the limitations concerning aerial control operations, it is good policy to use preventive ground control operations whenever possible. The components of ground operations are:

- training and equipping farmers and Village Brigades;
- early season surveys;
- weather monitoring;
- increased survey and ground application teams.

The MOA has standard and motorized backpack sprayers (Echo Mist Blowers) in good supply, most of which were donated by the Japan International Cooperation Agency (JICA) within the past two years. Spare parts for the latter are stored at Chitedze. These units are used for virtually all ground control operations, and vehicle-mounted sprayers are not available. Vehicles for transporting equipment and personnel into the field are scarce, and vehicle maintenance and spare parts have been serious problems. Adequate supplies of applicator safety gear (also donated by JICA) --protective clothing, gloves, respirators, boots, and goggles--are on hand.

3.5.5 Integrated Pest Management - IPM.

Integrated Pest Management uses all available control methods to achieve the most economically and environmentally sound management program. It is considered to be the preferred approach to pest control. IPM is not an alternative to chemical pesticide use; instead it is an integration of methods which may reduce use of pesticides by employing them more judiciously. Determination of intervention thresholds, correct timing of sprays based on pest population dynamics, and use of non-chemical control agents are among examples of modern and prudent pest management methods.

IPM can decrease pest losses, lower pesticide use, and reduce overall operation costs, while increasing crop yield and stability and ensuring environmental safety. Successful IPM programs have been developed for a variety of pests on various crops. Specifics of an IPM program will depend on the crop,

cropping system, pest complex, economic values, social conditions, availability of personnel, and other factors and constraints. The following steps illustrate the development of an IPM program.

Step 1: Identify the Major Pests, and Establish Intervention Thresholds.

Dozens of potentially harmful species may infest a crop. However, only a few pest species cause substantial crop loss. The pests which recur at intolerable levels on a regular basis are known as primary pests, and are the focus of IPM programs.

The criterion that determines whether taking action to control a harmful species is profitable is called the intervention threshold (or economic injury level). The intervention threshold is that point above which control actions should be taken, and below which no actions are necessary. The economic injury level may be expressed in different ways depending upon the crop and the pest. Examples of injury level indicators could be:

- Numbers of insects per plant.
- Percentage of fruit damaged by a given pest.
- Numbers of weeds per square meter.

Several factors will influence the intervention threshold for a specific pest: crop variety and stage of development, value of the crop, presence of natural enemies, cost of control measures, as well as external costs to health and the environment. The intervention threshold depends on the relationship between pest intensity and yield loss, and the economics of reducing the damage. It will therefore change as these variables change. The intervention threshold developed in one area will not likely be appropriate for use in a different area.

Research is needed to determine the initial intervention threshold. This threshold level must be thoroughly tested and verified under actual field conditions. The level can be refined as more information becomes available, and as it is used in the field.

Step 2: Select the Best Mix of Control Techniques.

All pest management methods and practices should be considered for an IPM program. First consideration should be given to use of preventive measures:

- Resistant crop varieties.
- Biological control (conservation or augmentation of natural enemies already present or introduced)
- Cultural control (cultivation, crop rotation, use of pest-free seed and planting stock, fertilizer management, and intercropping)

It is likely that farmers may already be using one or more of these preventive measures. It is therefore important to talk to the farmers before determining which measures are needed.

Pesticides should be used only if no practical, effective, and economic nonchemical control methods are available. Once the pesticide has been carefully chosen, it should be applied only to keep the pest below the intervention threshold. Pesticides will impact non-target organisms besides the pest, and may cause harm to humans, livestock, honey bees, natural enemies, and the natural environment.

Step 3: Monitor the Fields Regularly.

The growth of pest populations is usually closely related to the stage of crop growth and weather conditions. However, it is difficult to predict severity of pest problems in advance. Crops must be inspected regularly to determine levels of pests and natural enemies, and crop damage.

PPS survey personnel and agricultural extension agents can assist with field inspections. They can train farmers to differentiate pests from non-pests and natural enemies and to determine when crop protection measures, perhaps including pesticides, are necessary.

Step 4: Use All Control Methods Correctly and Safely.

Each pest control method has both advantages and disadvantages. DARTS and extension agents should learn as much as possible about each control method. Education programs should be developed to teach farmers how to use the available control methods safely and correctly.

Step 5: Develop Education, Training, and Demonstration Programs for Extension Workers.

Implementation of IPM depends heavily on education, training, and demonstration to help farmers and extension workers develop and evaluate the IPM methods. Hands-on training conducted in farmers' fields (as opposed to a classroom) is a must. Special training for extension workers and educational programs for government officials and the public are also important.

IPM is a sensible approach to pest control whereby all existing control methods (pesticides, biological control, cultural control), mitigating factors, environmental concerns, climatic conditions, and ecosystem interrelationships are integrated to assist in control operation decision making. While pesticides are part of the total IPM strategy, other methods are considered, with the choice dependent on the methods that most closely fit the situation. Timing of pesticide application is an important factor in IPM, with the early season approach favored because of the low amount of pesticides used. IPM is not a pest control method itself, but is a way of systematically considering options available in light of the physical and biological environment.

3.6 Pesticide Management

While there are many methods of l/g management, the most commonly used is chemical pesticides. While pesticides kill pests, they also affect other living organisms in the ecosystems in and around cropping areas. In addition, misuse or overuse of pesticides results in higher overall operational costs. This is not only because of the direct cost of the pesticide, but also because of reduction in natural enemies in the crop ecosystem.

The possible impact of pesticides on the environment and associated health risks to humans makes the way pesticides are selected and used an important aspect of management programs. Due to the environmental and biological diversity of Malawi, pesticides should be used with extra caution, and only when necessary.

To use a pesticide in a specific area at specific time, it is necessary to have detailed knowledge of the physical and chemical attributes of the product, the ecology of the area to be treated, and the biology of the pest. Pesticide selection for

l/g control requires the following concerning the pesticide itself:

- Effectiveness at low application rates;

- Minimal effects on nontarget organisms, including people and animals, and specifically predators and parasites of locusts and grasshoppers;

- Minimum persistence of residues on and in native fauna and flora, water, soil, and crops;

- Low toxicity and ease of handling;

- Good storage capacity, including shelf-life;

- Compatibility with existing application equipment;

- Cost efficient.

3.6.1 Pesticide Selection and Distribution

Although a number of pesticides have been used in Malawi against locusts and grasshoppers in the past, any pesticide involved in an operation funded by the USG must be approved for use in the United States by the Environmental Protection Agency (USEPA). Several approved pesticides are listed in the Programmatic Environmental Assessment (PEA). The PEA and subsequent amendments (APPENDIX G - unclassified cable State #118760) should be referred to during both the planning and implementation phases of l/g management. In addition, regulations governing the use of a particular pesticide, as set forth on the label, must be followed.

Malathion, **Acephate**, and the two synthetic pyrethroids **Lambda-cyhalothrin** and **Tralomethrin** are among the pesticides preferred for use in terrestrial ecosystems. For use near aquatic ecosystems (or all cases with the possibility of contamination of water), **Acephate** would be the pesticide of preference from the environmental standpoint, as it is a systemic, and best used for larval control. In addition, Acephate is considered one of the safest pesticides in use. **Carbaryl**, suggested by the PEA, is toxicologically acceptable, but is more difficult to store and apply (especially from aircraft) than other approved pesticides and is very toxic to bees. **Diazinon** and **Chlorpyrifos** are registered for use; potential environmental problems indicate they should be used with caution. **Fenitrothion** should be used only with extra

precautions and with mitigative measures. Water resources in Malawi should be protected from pesticide contamination as much as practicable. Therefore, the pesticides preferred for terrestrial use should be the ones favored for USAID procurement.

Chlorinated hydrocarbons, such as **Dieldrin** and **Lindane**, are not acceptable for use under any circumstances, due to their environmental persistence, bioaccumulation, acute toxicity, and broad-spectrum target range. It should be noted that U.S. funds cannot be used in any way whatsoever in connection with these pesticides. This includes funding any aspect of ground or aerial application, support of aircraft which spray chlorinated hydrocarbons, or funding the transport of such materials, among others.

DARTS is responsible for maintaining and distributing agricultural pesticide stocks in Malawi. The pesticide used in previous locust/grasshopper campaigns has been Fenitrothion 96% ULV and 50EC. No formulation is done in the country, and almost all current stocks have been donated by JICA. Some active ingredient assessment can be done at the GOM Bureau of Standards in Blantyre, but it is done more often by Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), with samples being sent out of country. The major depot is at the DARTS Chitedze Research Station. Pesticides are distributed annually from there to other two Regional Research Stations and ADDs as needed operationally. Empty containers and much of the unused stock is returned to Chitedze at the end of the control season.

Pesticides used for cattle dip tanks and for tsetse control are also distributed by government agencies. Acaricides are used in roughly 400 dip tanks country-wide. Phenols and pyrethroids are used in treated target control of tsetse flies, minimizing application and storage of pesticide for this use. There is also much uncontrolled importation of pesticides in the private sector.

3.6.2 Pesticide Labeling

Pesticide labeling is a way to give important information to the pesticide user. The label is the main and often only medium for instructing users in correct and safe use practices. Part of the labeling process is pesticide registration by host countries. Both registration and proper labeling require good solid legislation at the national level. A Pesticide Act is currently in draft, and approval by Parliament is expected. Malawi has had no regulations governing imports, exports, and distribution of pesticides, and a strong program of enforcement of the existing

licensing and labeling program components of the proposed legislation would be an important step in achieving safe use of pesticides.

The pesticide product label can be used effectively to communicate a number of important properties of the pesticide and precautions appropriate to its use. In addition to directions for use, the label should include needed protective measures, first aid measures, precautions recommending against use in certain environments, methods of container disposal, and application rates for particular pest species.

Pesticide labeling in Malawi tends to be variable, as no legislative standards are in place. In general, pesticides in the original container carry a label with adequate information for application. Some labels, though not all, include some information on first-aid or disposal. Unfortunately, some of the PPS-stocked pesticide containers have either lost the labels that did exist, or labels have been rendered illegible through handling and exposure.

While labeling must be specific to local needs and the social environment of Malawi, the FAO has prepared a global set of guidelines which can assist a labeling program. In addition to enforcing legislation, the GOM should insist that donated pesticides be labeled in comprehensive language as required by donor country law, and in the language widely used by the farming community in the country.

3.6.3 Managing Pesticide Stocks

A well maintained and secure pesticide storage facility is required before initiating a U.S. pesticide donation. With a good pesticide management system in place, both donated and purchased pesticides can then be controlled and utilized as needed. A good storage area should have a fenced and covered area for the pesticides. A pesticide storage warehouse should:

1) be isolated from dwellings in order to avoid fire, leakage, and water contamination;
2) be supplied with water in order to clean spills and fight fire;
3) be aerated to avoid toxic fume concentration;
4) have a current inventory of pesticide stocks;
5) have protection gear such as suits, boots, gloves, goggles and breathing masks;
6) have a first aid kit with antidotes;

7) be staffed with trained personnel who are familiar with measures to take in cases of poisoning;

8) be fenced and securely locked to prevent entry by uninvited guests including children;

9) have a danger sign (skull and crossbones) placed on the point of entry.

A management system is needed to record the date each pesticide arrived at the facility, how long it stays in storage, and when it is removed for use. In addition, the storage requirements for each pesticide must be posted and known by the management staff. Stored pesticides must be tested periodically to insure that the active ingredient is as described on the label, and that the formulation concentration is correct. Also the disposal of unused and obsolete pesticides, and the destruction of their containers, must be part of the management system.

Success of locust and grasshopper campaigns depends on availability of pesticides in the areas which need treatment. Pesticides should be placed in a safe and secure storage area as close as possible to agricultural areas which will likely need treatment. In Malawi, the major pesticide storage area is at Chitedze Research Station, with distribution of products to the other Regional Research Stations and ADDs done according to need and severity of the insect threat. The pesticide storage facility is a brick school building with a metal roof. The building appears secure, and is fenced and guarded, but is situated adjacent to a school. There is a total of roughly 10,000 l in liquid stock--mostly Fenitrothion and Sumithion. The storage facility appears to have been cleaned up considerably from several years ago. Containers are stacked and palleted, and there was no visible leakage or outside storage. Pesticide storage facilities at ADD Offices vary, but many are substandard, with drums sometimes being stored outside and unsheltered. Spillage has been a problem.

The central storage facility at Chitedze is inadequate, and needs to be upgraded or (preferably) relocated. Improvements should be made in storage facilities at ADDs and the other research stations. Care in management must be taken to prevent unwanted stock accumulation. This has been a very real problem for other countries involved in l/g management; a lack of planning and coordination has resulted in stockpiles of pesticides at some bases, and shortages at others. This seems to be a result of a lack of training in the managerial aspects of pesticide storage.

In addition to management of the pesticides themselves, the ADD Offices must adequately manage pesticide application equipment. Some of this equipment, donated by JICA, is reasonably new, and well-supplied with spare parts. Some older equipment, however, has deteriorated and spare parts are difficult to maintain. Adequate maintenance of all equipment must remain a priority with PPS, in order to ensure that it is clean and in good working order.

3.6.4 Obsolete Pesticides and Containers

Once a pesticide has been used, the management operation is left with an empty container. This container can be either reused or destroyed. If reused it should only be used for storage of the same pesticide, and by authorized persons/suppliers. <u>It should never, repeat never, be used to store water or food</u>. Even though the pesticide is gone, enough is left to cause poisoning, especially in the very young or old. Further, small quantities of pesticides will make the human body more susceptible to other diseases. PPS burns or punctures many of the empty containers from control efforts but a large number simply disappear. The Pesticide Suppliers Association of Malawi supports the FAO code of conduct on destruction of pesticide containers, but difficult to enforce, and containers are regarded as quite valuable in Malawi.

Malawi, like other countries in sub-Saharan Africa, is faced with the problem of stocks of expired or substandard pesticides which were acquired through commodity aid programs or unplanned importations. There is no policy developed which adequately covers disposal of such chemicals as well as empty containers. A 1995 inventory list shows 127 metric tons of these materials in the country: 21 tons in private sector stocks and 106 in government facilities. Most of government stocks are at Chitedze, though some stocks have accumulated at Bvumbwe and Makoka Agricultural Research Stations, as well. MOA is attempting to update this quantity and distribution list and anticipates approaching FAO about funding for disposal. Sumitomo Chemical Company is supporting the project, as the source of much of the JICA-donated pesticide.

3.6.5 Disposal of Unwanted Pesticides

When a pesticide is no longer needed, or is degraded chemically due to heat or time it will need to be disposed of.

As many of the obsolete stocks are in liquid formulation, one disposal method is high-temperature incineration at a suitable facility. Incinerators in Europe or other countries may also be used for disposal operations. Disposal is a complex problem not yet clearly resolved in technologically advanced countries, but available methodology should be made available to developing countries at the earliest opportunity. Because of the current research in this area, and the potential for political ramifications, USAID/Malawi should consult AID/W prior to any pesticide disposal assistance program.

3.7 Cultural and Biological Management

Numerous non-chemical methods exist for pest management in general, and have been used against locust and grasshoppers. For example, crop varieties which develop at different rates from the commonly planted varieties, or which show resistance to insect attack, may be applicable in the long-term. Sorghum, for example, is more resistant to attack by grasshoppers than millet. Other cultural methods, such as trap cropping, residue burning, trench digging in front of locust larval path, and intercropping may well have merit as well. Simple techniques such as using protected courtyards for tree seedling nurseries or covering seedlings with mosquito netting can be effective in small scale and limited cases.

Farmer experience with traditional or innovative control methods should be encouraged and incorporated into an overall l/g management program. If villagers can be recruited as participants in control efforts, such as a Village Brigade, a field can be protected with a minimum of pesticide use and expense.

Research on field use of microbial agents in locust and grasshopper control is currently being implemented by USAID and other international organizations. The fungal pathogen Beauvaria bassiana has been tested in the US and in parts of Africa for its control potential. Preliminary results from Mali indicate that B. bassiana can be an important control agent, especially if used as part of an overall biointensive program. Additional work will be needed to determine its specific usefulness on the locust species in Malawi, but the geographically and ecologically circumscribed breeding areas of the Red Locust would seem to provide an ideal field situation for evaluation of fungal control techniques.

In working with microbial pest control agents, attention must be given to handling and application techniques. Some may have a short shelf life and must be used soon after production. In addition, climatic and environmental conditions in the field will impact the microbial control agent. Formulation appears to play an important part in the longevity of these materials under field conditions.

Another research recommendation is the search for local and possibly more species-specific pathogens. Large population explosions of l/g might be conducive to the development of epidemics of endemic pathogens. At the time of population collapses a search for more effective pathogens would be appropriate. Such a search should be done in collaboration with laboratories familiar with pathogen isolation.

Research is needed on plant extracts as bio-pesticides and antifeedants which may have use as components of IPM and may be appropriate for Malawi. Some materials may already be used by villagers as a traditional means of insect control.

Other fruitful research areas might include use of synthetic insect growth regulators (IGR). These agents are considered alternatives to conventional pesticides because of their different modes of action, and incorporation of IGRs into the 1993 African Migratory Locust control program in Madagascar showed that the technique has promise. However, there may be impact on non-target aquatic invertebrates.

Biological control research is being done at Bunda Agricultural College on cassava whitefly and mealybug. This SEA encourages greater communication between MOA personnel and College researchers as a way to extend promising results in the laboratory into field situations, and to widen the investigation of control possibilities to a greater range of species. GTZ is also supporting importation of natural enemies of cassava pests from International Institute for Tropical Agriculture (IITA) rearing facilities in West Africa, and this SEA supports such cooperative endeavors which can result in minimizing the need for direct chemical control.

3.8 Safety and Health Care System

3.8.1 Public Awareness

In conjunction with USAID assistance in locust and grasshopper efforts, it is important that the Government of

Malawi monitor both human health and the natural environment. In regard to protecting human health, it is necessary to educate both the medical community and pesticide applicators about the potential hazards of pesticides, and steps to mitigate these. Application of a pesticide in a given area should be preceded by public awareness and extension activities and education of the users. The Malawi public must be informed that pesticides are dangerous and that empty pesticide containers should not be used for feed, food or water storage. A good public information program would include:

- information on the specific pesticides and labels;
- safe methods of pesticide transport and storage;
- measures in cases of container leakage;
- conditions for pesticide use;
- safe use of application equipment;
- identification & prevention of pesticide poisoning.

Pesticide educational programs can be instituted by agents from the Ministry of Health. Health education and extension programs can also provide information on first aid in pesticide poisoning cases. The inherent toxicity of used pesticide containers is an important subject area, and should be specifically directed to women who might use the containers for cooking or holding water. Components of a pesticide public awareness program should include photographs, posters, or prints on cloth. These should be given to agents as visual aids to hang on walls of schools, dispensaries, and on large trees in villages and towns.

Radio broadcasts are an important part of a public information campaign, including pesticide awareness information in the form of brief safety announcements, musical programs, interviews, debates, and dramas. Discussions of pesticide regulations and legislation should also be presented, including information on which pesticides are legal and which are prohibited in Malawi. This will allow potential buyers and users to know what pesticides should be accepted and what should be refused.

3.8.2 General Pesticide Safety Concerns

Because of the role pesticides can play in potentially increasing agricultural productivity, the Government of Malawi regards these chemicals a useful part of agriculture. Unfortunately, pesticides can be misused by both farmers and PPS agents, presenting hazards to the human environment and the natural ecology. For example, pesticides intended for

agricultural or public health purposes may be misused for general household insect control.

In addition to the potential for unsafe application, pesticides may also affect public health by being stored improperly. It is important to keep stored pesticides in good condition, away from humans and other animals. Any unwanted or leaking pesticides must be repacked or disposed of as soon as possible. Because pesticides have the potential for misuse, it is essential that existing and proposed legislation on pesticide use be enforced. While abuse may still occur, implementation of regulations will provide a sound base for promoting public health and environmental integrity.

3.8.3 Applicator Safety Training

USAID has supported pesticide applicator safety training in the past in Africa, and has found such training to be a useful and often sustainable use of funds. It is important that well-trained PPS agents are available to work with any U.S.-funded pesticide donation.

The incorporation of hands-on pesticide safety and application training courses into the academic curriculum for agronomy and other agricultural degrees is essential. This approach will allow trained individuals to interact with the actual users of pesticides.

Properly trained PPS agents and agricultural extension agents are encouraged to work with farmers in "Train-the-Trainer" programs. This type of training will allow essential information on pesticide safety and application to reach all who may be working with pesticides. This type of training is strongly encouraged by USAID.

An additional approach is an emphasis on pesticide safety training among private suppliers of pesticides. PPS could work effectively with PSAM and the private sector to ensure correct use of imported pesticides.

3.8.4 Health Care System

Malawi's MOH is responsible for providing health care services in its hospitals and health centers. Health care is organized on regional, district, and peripheral levels. Tertiary hospitals under MOH include three central hospitals (Kamazu

Central in Lilongwe, Queen Elizabeth Central in Blantyre, and Zomba General in Zomba) and 24 district hospitals. Roughly 250 secondary-level facilities provide curative care, maternal and child care, and community health services. Primary services depend upon roughly 1000 Health Surveillance Assistants (HSA) to promote family health and nutrition at the community level. In addition, the Christian Hospital Association of Malawi (CHAM) operates about 150 health care facilities. The public health sector depends upon a referral system which provides increasingly sophisticated services at successive levels. In rural areas, the first point of contact is HSA, followed by a sequence of referrals from clinic to rural to district to central hospital. A 1993 Center for Development Information and Evaluation study of the health sector reported that management of health services at district and peripheral levels was fragmented and redundant, and that all levels suffered poor communication and needed to strengthen planning and training (Schmeding et.al., 1993).

Quality of health care in Malawi is limited by a marked shortfall in trained personnel and the domination of curative over preventative services. MOH estimated in 1987 that Malawi had 53,000 inhabitants for each doctor, 3000 for each nurse, and 7127 for each hospital bed. All three ratios are quite high by any developing country standard (Fig. 5).

All hospitals and health centers in an area which is likely to be involved in a pesticide spray operation should be provided with information materials on the pesticides to be used in the area. The personnel of these centers should be given the necessary training to recognize and treat pesticide poisonings. Information is available in the USEPA handbook on pesticide poisonings (Morgan, 1989).

The local health care delivery system in Malawi may not be equipped to handle a serious case of poisoning, which, if it occurs, is most likely to involve an applicator. Therefore, application crews need to be self-sufficient in handling medical emergencies. Supervisors must be familiar with safe handling of pesticides and be able to administer any needed first aid, including antidotes for pesticide poisoning. All who are working with pesticides should be familiar with the early warning signs of poisoning. Workers must be removed from contact with pesticides at the first signs of poisoning.

3.8.5 Potential for Human Health Impact

The potential for adverse effect on human health increases significantly when pesticide use is high. When large areas of

the country are treated and large quantities of chemicals are being shipped, distributed, and applied, the probability of exposure of humans (and the environment) is proportionately greater. This SEA advocates prevention of human exposure as the best approach to minimizing adverse health impacts. A major aspect of prevention is to keep locusts at low population levels with preventative control strategies, as discussed in the previous section. Another major aspect, covered in this section, is prevention of human exposure.

3.8.6 Prevention of Human Exposure

The general population is most effectively protected from any adverse health effects by proper pesticide application techniques. Whether or not the application is safe for the general population depends on the toxicity of the pesticide, the formulation used, the concentration of the pesticide in the formulation, the frequency of application, the kind of equipment used, and the training of applicators in safety precautions. In areas of high population densities, treatment-free perimeters can be observed in order to avoid exposure.

This SEA advocates training, educating, and supervising the applicators as the most effective way to ensure that exposure of the general population is kept at or below acceptable levels. Such training and supervision has to be an ongoing effort and has to be detailed enough to include the differences among individual pesticide active ingredients, formulations, and application methods.

The general public is at minimal risk if the necessary precautions are taken, but should nevertheless be informed about pesticide use. This can be achieved by a number of means, such as posters, the radio and local newspapers. DAES employs sound trucks to notify populations in affected areas 24 hours prior to control. Public health advisories given by radio broadcasts were effective in other countries prior to past aerial applications and should be included in plans for future applications. This is especially important in areas where people may eat locusts. It also should include public education about the dangers of improper pesticide container reuse.

Pesticide applicators are generally at the highest risk for any adverse effects. The risk level is much higher than that of the general population because applicators are handling concentrated products. In addition to the training and supervision indicated above, applicators should be thoroughly

Figure 5. Population per Health Care Staff, 1990
(Center for International Health Information. 1995)

familiar with the level of danger from the pesticide, and should be provided with equipment that is in good working condition in order to minimize accidents. Such equipment may include pumps to transfer pesticides, body protection in the form of gloves and aprons, safety shields for the face to prevent dermal exposure, and respirators to prevent inhalation.

It is particularly important that some form of protection is worn during the short periods while handling the concentrates. If at all possible, long-sleeved shirts and full-length pants should be used, and washed frequently. PPS logos or patches on the protective clothing items can help induce use and care.

Exposure of applicators is mostly through the skin. Though the skin usually provides a significant barrier to the entry of some pesticides, even these will penetrate into the body if the contamination is left on the skin. In addition, some pesticides penetrate the skin more readily. Therefore, applicators should wash any exposed areas of the body frequently. If water is scarce, the wash water could be saved for use in diluting pesticides.

3.8.7 Monitoring of Human Exposure

Simple and effective health monitoring of those involved in pesticide handling, application, and storage is essential to a good management operation. This involves teaching all involved with pesticides what the symptoms of pesticide poisoning are, and when first-aid might be required. It is especially important to use behavioral observation to decide if workers should be immediately removed from pesticide exposure.

The GOM should have the capability to monitor both behavioral symptoms of pesticide poisoning, and such blood-chemistry manifestations as acetylcholinesterase (AChE) inhibition. AChE inhibition testing is not done presently by PPS, and there is no supply of kits in the country. Testing for AChE inhibition is fairly simple and inexpensive, and can be performed by trained health workers in the field. The background cholinesterase level for each person involved with pesticides must be determined prior to exposure, and testing should be performed at intervals throughout the season to ensure that no worker is being overexposed to pesticides. (It should be noted that testing AChE is recommended only when pesticides in the organophosphate class are used, e.g Malathion, Sevin, etc.).

Measurement of residue levels in the environment can also be a valuable source of information for assessing exposure and determining if modifications to treatment operations are needed. At present, DARTS is dependent on technical documentation to evaluate non-target effects of pesticides. There is concern about analysis of pesticide residues, especially on food materials. Residues are routinely analyzed on tobacco for export, but with adequate legislation and increasing agricultural diversity and pesticide use, there is a need for extending residue analysis to other food materials. This SEA supports development of such a facility, perhaps on Southern Africa regional basis, as data are lacking on pesticide degradation under local conditions and on residue persistence on food crops.

3.9 Environmental and Non-target Impact

3.9.1 Environmental Impact Minimization

Due to their toxic nature, pesticides will impact both crop and nearby ecosystems. Care must be taken during the handling, transport, application, and disposal process to insure that as little impact as possible is allowed in non-target areas. In addressing this issue in regard to operational planning, risks to the environment must be considered in terms of early season management, versus late season large-scale operations. The latter would involve considerably greater amounts of pesticide, an correspondingly greater risks.

Because of the additional risks incurred in late season control operations, USAID/Malawi should support management operations designed to avoid such risks. Early season survey and management can prevent late season control operations, with significantly less pesticide usage. Preventive management operations emphasizing surveys which locate and delimit pest populations, and spot treatment operations intended to reduce population numbers using as little pesticide as possible are favored.

Because the number of hectares sprayed is reduced, early season control operations use less fuel. Vehicle wear is also reduced and vehicles will last longer. Because early season control strategy uses considerably less resources, PPS can be better able to implement it without donor assistance. A greater degree of self-sufficiency and control of the situation by PPS itself is allowed.

If pesticide use is necessary, the type of ecosystem in the treatment area, and associated non-target species, should be major factors in determining the choice of pesticide. A pesticide's characteristics, such as selectivity, mobility in ground water, persistence, and metabolic products should be considered as important as effectiveness against target species. In addition, application methods should be considered, with ground application having less impact than aerial treatment.

The response of different animals and ecosystems to pesticide exposure varies dramatically. For example, carbaryl has only low toxicity to birds, but is extremely toxic to aquatic invertebrates and certain estuarine organisms. While application of carbaryl may be appropriate in areas providing upland habitat for birds, its application in areas important to waterfowl and migratory shorebirds, such as lakes, wetlands, or coastal areas should be prohibited.

Although this SEA strongly recommends against any pesticide applications in aquatic systems, acephate is relatively nontoxic to freshwater fish and invertebrates, and is the least likely of the selected pesticides to have adverse effects on aquatic habitats. Acephate should be one of the preferred pesticides if applications are necessary adjacent to aquatic systems, particularly in and around fragile areas or critical mammal, bird, or fish habitat. Due to its mobility in soils, however, acephate has the potential to contaminate ground water. The consideration of aquatic/wetland system fragility should be especially highlighted in the case of control decisions in Red Locust breeding areas.

3.9.2 Environmental Monitoring

Part of the overall pest management system is monitoring treated areas for potential environmental effects of pesticides. Monitoring can indicate negative impacts on flora and fauna, as well as detect improper application methods which can impact human health and increase operations cost. Measuring pesticide residues in the environment is an excellent way of monitoring, and require a residue analysis laboratory for full implementation. Pesticide use support should incorporate residue analysis into their project plans, and should include qualitative behavioral observations of non-target organisms near any pesticide target areas. PPS applicators must be trained to note unusual behavior among fauna of the area, and the practice of having control teams in vulnerable areas accompanied by a District Wildlife Officer should be continued.

Although monitoring is likely to produce variable results, it can be a valuable feedback tool in control operations. It can provide some general conclusions on effects and can be used in designing modifications of pest management activities. Given the large number of variables that can affect results and the limited resources likely to be available for monitoring, the most practical ways to assess the effects of pesticide applications may be mortality and population counts and behavioral observations. Baseline conditions for an indicator species and its habitat should be determined prior to pesticide application, and post-application monitoring should be conducted at intervals sufficient to allow assessment of both immediate and long-term effects. It is also important to select species with demonstrated sensitivity to pesticide exposure.

Aquatic habitats are often critical habitat to sensitive species and migratory birds. Therefore, pesticide use near such habitats should be avoided whenever possible. Care must especially be taken when pesticides are applied during or close to times of seasonal rains. This may lead to introduction of the pesticide into water supplies or aquatic systems in runoff. Because invertebrates are generally much more sensitive to insecticides than vertebrates, monitoring the observable effects of pesticide use on invertebrates, such as benthic organisms, should be the preferred method for monitoring aquatic habitats. Vertebrates, however, should not be ignored, as pesticide effects on them may be indirect, but no less severe.

A similar monitoring approach should be used for pesticide use in terrestrial ecosystems. Selection of soil microorganisms or other low-tolerance invertebrates as indicator species is recommended. Monitoring animals of economic value or threatened status should also be required. In cases where pesticide persistence is an issue, residues should be measured. Populations of vertebrate predators, such as birds of prey, are likely to fluctuate too much to make population counts an effective monitoring tool. However, reproduction monitoring of carnivores (e.g., observations of egg conditions, birth defects, infant mortality) may be a useful tool in determining the effects of pesticides known to affect reproductive success, particularly in cases where baseline data are known.

4.0 PROTECTED AREAS/PROTECTED ANIMALS AND PLANTS

Because pesticides will impact both crop and natural ecosystems, some system of natural resource protection is necessary. This can be accomplished by setting aside areas and

zones where pesticides are not used, or are severely restricted. Endangered animals and plants need to be taken into consideration in regard to habitat intervention. Since birds and fish are particularly vulnerable to direct and indirect impacts of pesticides, these organisms need to receive special consideration. Some areas should be set aside to be protected from pesticide use no matter how great the perceived pest control need.

Protection of animal and plant species and their habitat in turn preserves the regional biological diversity. In addition to protecting habitat and inherent existence value, Protected areas also provide a safe place for reproduction and regeneration of wildlife after losses from drought and poaching. The areas offer considerable potential for tourism, as well. Although Malawi's tourism industry is in its infancy, it offers great potential to the country's economy. Because it is relatively non-consumptive, has a high return value. In addition, protected plants may hold value for future industrial and pharmaceutical use. Protected areas can also contribute to local village economy through value-added income.

Malawi's DNPW is concerned with protection of fragile areas and conservation of biodiversity, and promotes policies and research that conserve wildlife and their habitats. This SEA recommends that mitigative measures associated with any l/g control activity be coordinated with activities of DNPW and appropriate NGOs.

Unfortunately, population pressure and basic economic needs are contributing to the degradation of forests, grasslands, watersheds and lakes in Malawi, and habitat for many of Malawi's plant and animal species is being lost. Drought and erosion further accelerate this habitat deterioration. **It is extremely important that any U.S.-funded l/g control program involving pesticides not contribute further to the environmental degradation already underway. Further, the United States should do its utmost to use methods and materials that have the least toxic effects on both crop and natural ecosystems.**

Fishing is an important source of food and livelihood in Malawi, where it is estimated that fish accounts for 60-70% of the animal protein available to the population. Lake Malawi yields most of the fish consumed in the country, with other important systems being Lakes Chilwa, Chiuta, and Malombe, and the Shire River (Fig. 3). Fish populations are liable to be indirectly affected by pesticides used in locust or grasshopper control operations because of direct toxicity to aquatic

invertebrate fauna (Keith, 1989), a source of food for most fish. As major fisheries are located in areas subject to locust invasion, they may be especially at risk as locust control efforts are implemented.

4.1 Protected Areas

Malawi has 11.6% of its land area designated as National Parks or Wildlife Reserves. All resources are protected in National Parks; animal populations are protected in the Wildlife Reserves. The five National Parks and three Wildlife Reserves extend from north to south through the country (Fig. 6).

Lake Malawi National Park was established in 1980 as the first freshwater and underwater national park in Africa. It was designated a United Nations World Heritage site in 1984. Lake Malawi National Park protects its large population of over 400 cichlid species, and islands and shoreline components (8700 ha) of the Park offer hippos, crocodiles, and abundant birdlife.

Nyika National Park (313,400 ha) in the north is the largest (besides Lake Malawi) and is located on a montane plateau with large herds of zebra, eland and antelope.

Kasungu National Park (231,600 ha), in the central region, contains the largest elephant herds.

Lengwe National Park (88,700 ha) is in the southern region. During the dry season, water is scarce in the park and artificial waterholes concentrate game animal populations (including herds of the rare Nyala antelope).

Liwonde National Park (53,800 ha) is on a flat area of the eastern Shire River watershed. The park has many elephants, hippos, lions, crocodiles, and a great variety of bird species.

Nkhotakota Wildlife Reserve (180,200 ha) is on the west of Lake Malawi in the central part of the country, and features elephants, sable antelope, warthogs and over 130 bird species.

Vwaza Marsh Wildlife Reserve (98,600 ha) is just below Nyika National Park, and has large herds of elephants, hippos, and buffaloes. It shares a border with the Luangwa Valley National Park in Zambia.

5.0 REFERENCES

Alomenu, H.S. 1989. Provisional Report on Pesticide Management in Francophone West Africa. Food & Agriculture Organization, Accra, Ghana. 58 pp.

Appleby, G., W. Settle and A. Showler. 1989. The Africa Emergency Locust/Grasshopper Assistance Mid-term Evaluation, Tropical Research & Development, Inc., Gainesville, Florida. 146 pp.

Boberschmidt, L., S. Saari, J. Sassaman and L. Skinner. 1989. Pesticide Background Statements, Volume IV, Insecticides. Agriculture Handbook No. 685, U.S. Forest Service, Washington, DC. 578 pp.

Center for International Health Information. 1995. Malawi Country Health Profile. CIHI Country Health Profile Series. Arlington, VA. 32 pp.

Department of Research and Environmental Affairs, GOM. 1994. Government of Malawi Climate Change Country Study: Proposal. Lilongwe. 27 pp.

Department of Research and Environmental Affairs, GOM. 1994. National Enviromental Action Plan. Volume 1: The Action Plan. Lilongwe. 104 pp.

DYNAMAC. 1988a. Results of the Mali Pesticide Testing Trial Against the Senegalese Grasshopper. Dynamac Corporation, Rockville, Maryland, USA. 111 pp + Appendices.

DYNAMAC. 1988b. Results of the Locust Pesticide Testing Trials in Sudan. Dynamac Corporation, Rockville, Maryland, USA. 84 pp. + Appendices.

FAO. 1971. Manuel sur l'Utilisation des Normes FAO pour les Produits Phytopharmaceutiques. Rome.

FAO. 1986. Code International de Conduite pour la Distribution et l'Utilisation des Pesticides. FAO, Rome. 28 pp.

GIFAP. 1988. Directives des Pesticides sur l'Utilisation, le Stockage. 62 pp.

Jensen, J.K. 1990. Alternative Methods for Disposal of Obsolete Pesticides. USAID Pesticide Disposal Conference, Niamey, Niger. January, 1990. 13 pp.

Keith, J.O. 1989. Environmental Effects of Insecticides used in Locust Control. Pilot Study in Senegal. Trip Report. Denver Wildlife Research Center, Denver. 7 pp.

Meinzingen, W.F. 1993. A Guide to Migrant Pest Management in Africa. FAO, Rome. 184 pp.

Ministry of Agriculture. Agricultural Communications Branch, GOM. 1994. Guide to Agricultural Production in Malawi 1993-1994. Lilongwe. 225 pp.

Ministry of Agriculture. Department of Agricultural Research. GOM. 1993. Technical Services Research Bulletin. Lilongwe. 226 pp.

Ministry of Economic Planning and Development, GOM. 1997. Economic Report 1997. Lilongwe. 118 pp.

Ministry of Economic Planning and Development, GOM. 1996. Food Security and Nutrition Bulletin. Lilongwe. 7(1): 44 pp.

Ministry of Research and Environmental Affairs, GOM. Environmental Affairs Department. 1997. Administrative Guidelines for Environmental Impact Assessment. Lilongwe. 65 pp.

Ministry of Research and Environmental Affairs, GOM. 1996. National Environmental Policy. Lilongwe. 35 pp.

Morgan, D. P. 1989. Recognition and Management of Pesticide Poisonings. 4th Edition. EPA-450/9-88-001. Environmental Protection Agency, Washington, DC. 207 pp.

Popov, G.B. 1989. Joint Nosema, Insect Growth Regulator and Insecticide Trials Project in Mali. Report of Consultant to Ciba-Geigy, FAO, and SPV. 25 pp.

Potter, C.S., M.G. Rutanen-Whaley, H. Khoury and A. Messer. 1988. Draft Environmental Assessment of the Tunisia Locust Control Campaign. Agency for International Development, Tunis, Tunisia. 48 pp.

Price Williams & Associates. 1987. Grasshoppers/Locusts. Looking back at 1986. Famine Early Warning System Special Report, USAID, Washington, DC. 26 pp.

Ravndal, V. 1989. An Overview of Issues Pertaining to Biological Diversity Conservation in Malawi. Natural Resources

Management Support Project (USAID Project No. 698-0467). Washington, D.C. 22 pp.

Schaefers, G.A. 1992a. Improvement of Pesticide Management in East Africa: The Potential Role of a Non-governmental Organization. Supplemental Report. African Pest and Environment Foundation. 26 pp.

Schaefers, G.A. 1992b. A Review of Pesticide and Environmental Management Capabilities in East Africa. Final Report. African Pest and Environment Foundation. 108 pp.

Schmeding, R., L. Ackerman, B. Schwartz, and S. Settergen. 1993. Evaluation of USAID Child Survival Programs: Malawi Case Study. USAID Technical Report No. 12. Center for Development Information and Evaluation.

Seubert, C. and C.L. McKay. 1989. Malawi Natural Resources Management Assessment. Natural Resources Management Support Project (USAID Project No. 698-0467). Washington, D.C. 39 pp.

Shannon, M., et al. 1987. Rangeland Grasshopper Cooperative Management Program, Final Environmental Impact Statement. Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Washington, DC. 251 pp + Appendices.

Steedman, A.(ed.). 1988. Locust Handbook. 2nd edition. Overseas Development Natural Resources Institute, London, England. 180 pp.

Strzok, P.P., E.B. Radcliff, H. Larew, R. Swanson and G. Ouedraogo. 1989. Design of a Neem Kernel Extract Project for Crop Protection in Mali. Agency to Facilitate the Growth of Rural Organizations, Minneapolis. 39 pp.

TAMS. 1989. Locust and Grasshopper Control in Africa/Asia, A Programmatic Environmental Assessment. TAMS Consultants, Inc., Arlington, Virginia, USA. 305 pp + Appendices.

USAID 1988. Grasshopper/Locust Workshop Report and References. Harper's Ferry, West Virginia, USA. 309 pp.

USAID 1989a. Locust/Grasshopper Management Guidebook. Office of Foreign Disaster Assistance, Agency for International Development, Washington, DC.

USAID 1989b. Implementation Plan for Government of Niger to Reduce Hazard of Surplus and Unusable Insecticides Acquired for

Use in the Locust/Grasshopper Program. Agency for International Development, Washington, DC.

World Environment Center. 1987. Pesticide Disposal in East Africa. New York, USA.

APPENDIX A
LIST OF PREPARERS
AND PERSONS CONTACTED

Government of Malawi

Ministry of Agriculture - Lilongwe

Kampani, Defrea V.: Director, Agricultural Extension Services

Matabwa, C.J.: Director, Agricultural Research and Technical Services

Chinombo, D.O.: Deputy Chief Veterinary Officer, Department of Animal Health and Livestock Development

Thaulo, Gertrude: Agricultural Extension Officer, Crop Protection

Ministry of Agriculture - Chitedze Agricultural Research Station

Saka, A.R.: National Research Coordinator for Soil Fertility and Plant Nutrition, ARTS

Theu, M.P.K.J.: Team Leader for Pathology, Biological Science, Weed Science and Quarantine, ARTS

Ministry of Tourism, National Parks, and Wildlife

Jiah, R.M.: Principal Parks and Wildlife Officer, Department of National Parks and Wildlife

Ministry of Forestry, Fisheries, and Environmental Affairs

Kabwaza, Ralph P.: Director, Department of Environmental Affairs

Vokhiwa, Zipangani M.: Deputy Director, Department of Environmental Affairs

Ministry of Lands, Housing, Physical Planning and Surveys

Nkhata, Geoffrey: Commissioner of Lands

USAID/Malawi

Dunn, James: Chief of Office, Supervisory Agricultural Development Officer

Nyirongo, Mexon: Health Development Specialist, HPN

Shumba, Stephen E. C.: Agricultural Specialist

A.I.D/Washington

Evans, David A.: Contractor, AFR/DRCO, Professor of Biology, Kalamazoo College

Other Contacts

Chibonga, Dyborn C.: Secretary, Pesticide Suppliers Association of Malawi

Gama, Jino: Population Economist, Management for Development Programme, UNDP/GOM

Kagawa, Akio: Assistant Resident Representative, Japanese International Cooperation Agency (JICA)

McCulloch, Laurie: IRLCO Evaluation Team, FAO

Nyirenda, Greenwell D.C.: Professor of Entomology, Bunda College of Agriculture

Teri, J.: Research Specialist, International Institute of Tropical Agriculture

APPENDIX B

PEA for LOCUSTS/GRASSHOPPERS: SYNOPSIS OF ENVIRONMENTAL ASSESSMENT PRIORITIES

BASIC PRE-CONDITION OF PROGRAM

Recommendation 1. It is recommended that USAID continue its involvement in Locust and Grasshopper control. Operationally, the approach to be adopted should evolve toward one of Integrated Pest Management (IPM).

This recommendation should be applied in the context of the specific needs of Malawi. USAID/Malawi supports IPM in the management of locusts and grasshoppers, as well as other insect pests.

INVENTORY AND MAPPING PROCEDURES

Recommendation 2. It is recommended that an inventory and mapping program be started to determine the extent and boundaries of environmentally fragile areas.

This recommendation can be part of future USAID/Malawi involvement with assistance efforts. Maps should include specific areas to be protected, some with a total ban on pesticides for grasshopper or locust control and some with a high priority for restricted use of pesticides. Areas which may have potential for the testing of pesticide alternatives should also be included.

Recommendation 3. It is recommended that a system for dynamic inventory of pesticide chemical stocks be developed.

Because of past inadequate management practices in Malawi, stocks of pesticide have been allowed to accumulate and degrade. In addition, stored pesticides are not always handled carefully or tracked to insure correct use and disposal. Improvements in the system for managing pesticide stocks must be implemented to protect human health and the environment and to minimize chances of pesticide products becoming obsolete.

Recommendation 4. It is recommended that USAID take an active role in assisting host countries in identifying alternate use or disposal of pesticide stocks.

A plan for managing obsolete stocks has been drafted with the support of USAID Washington. This should include the periodic testing of stored pesticide stocks to insure that the material is usable. Unwanted stocks in Malawi should be disposed of only with technology that best fits the local situation. High priority should be placed on minimizing the future accumulation of any unwanted pesticide.

Recommendation 5. It is recommended that FAO, as lead agency for migratory pest control, be requested to establish a system for the inventory of manpower, procedures and equipment.

This SEA supports that recommendation as an AID/W-coordinated and supported activity.

MITIGATION OF NON-TARGET PESTICIDE EFFECTS

Recommendation 6. It is recommended that there be no pesticide application in environmentally fragile areas and human settlements.

Any future spray operations or pesticide donations for use in Malawi should be accompanied by a requirement prohibiting use in some areas and limiting use in others and requiring appropriate buffer zones. The areas of total prohibition are designated wetlands, national parks, national forests, and fragile areas. Buffer zones and other reserves should restrict pesticide use, and encourage traditional and non-chemical methods. Villages, towns, cities, or any other human settlement will not be sprayed.

Recommendation 7. It is recommended that pesticides used should be those with the minimum impact on non-target species.

Pesticide recommendations in the PEA and subsequent lists of USAID-approved anti-l/g pesticides should be followed until research results indicate that more environmentally safe pesticides are available for use. Investigation of traditional and cultural methods of control is also strongly encouraged as a

USAID/Malawi activity. This SEA does not contain a list of pesticides because it accepts the pesticide selection in the PEA.

Recommendation 8. It is recommended that pre- and post-treatment monitoring and sampling of sentinel organisms and water and/or soils be carried out as an integral part of each control campaign.

This recommendation should be implemented to some extent if possible, but may be difficult to fully implement in Malawi, due to both the expense and a lack of supportive infrastructure. A program of research monitoring is important both as a basis for design of operational monitoring and as a means of establishing statistically verifiable base line data. In addition, periodic sampling observations of target and non-target mortality, population numbers, and behavior should be made at locations involved in pesticides use.

APPLICATION OF INSECTICIDES

Recommendation 9. It is recommended that one of the criteria to be utilized in the selection of control techniques should be the minimization of the area to be sprayed.

A number of operational procedures should be followed to minimize the area to be sprayed. 1) Emphasis should be on an early and vigorous surveillance program, thus allowing early treatment operations and reducing the amount of pesticide used; 2) Crop protection operations should utilize economic thresholds to the extent possible; 3) A program of identifying non-treatment areas and minimum treatment areas should be adopted; 4) Training of all decision-making individuals should emphasize the importance of restraint in use of pesticides; 5) Farmers and villagers should be included in training and subsequent survey and application operations.

Recommendation 10. It is recommended that helicopters should be used primarily for survey to support ground and air control units. When aerial treatment is indicated, it should only be when very accurate spraying is necessary, such as close to environmentally fragile areas or for localized treatment.

The treatment program in Malawi should emphasize early season ground application. However, during rainy season treatment operations, road conditions may necessitate the use of aircraft. In addition, some areas may not be accessible except by helicopter. The AID/W (Forest Service) Aerial Application Guidelines should be followed in any such operation.

Recommendation 11. It is recommended that, whenever possible, small planes should be favored over medium to large two- or four-engine transport types {for application of pesticides}. In all cases, experienced contractors will be used.

This SEA supports this recommendation.

Recommendation 12. It is recommended that any USG-funded locust/grasshopper control actions which provide pesticides and other commodities, or aerial or ground application services, include technical assistance and environmental assessment expertise as an integral component of the assistance package.

This SEA agrees with this recommendation. In addition, this SEA strongly supports both long- and short-term training to be integrated with USAID-provided technical assistance.

Recommendation 13. It is recommended that all pesticide containers be appropriately labeled.

This SEA agrees with the recommendation and urges the GOM to give high priority to enforcing pesticide legislation and implementing laws requiring a good clear label. It is suggested that the GOM follow the FAO pesticide label guidelines.

DISPOSAL OF PESTICIDES

Recommendation 14. It is recommended that USAID provide assistance to host governments in disposing of empty pesticide containers and pesticides that are obsolete or no longer usable for the purpose intended.

USAID/Washington and the FAO are currently developing guidance on disposal programs for unwanted pesticides and empty containers. In addition, several pilot disposal projects are being implemented. USAID/Malawi should follow such disposal

guidance when available, and should continue to assist with proper pesticide management. Proper disposal of empty barrels is especially important.

PUBLIC HEALTH AWARENESS

Recommendation 15. USAID should support the design, reproduction and presentation of public education materials on pesticide safety (e.g., TV, radio, posters, booklets). This would include such subjects as safely using pesticides, environmental awareness, pest management techniques of locusts and grasshoppers, and the potential hazards of pesticides. The goal would be to enable policy makers and local populations to recognize and avoid potential health problems related to pesticide applications.

Collaboration between the MOA and other ministries should ensure the development of public and applicator education on pesticide safety, pesticide poisoning recognition, avoidance, and treatment. In addition to receiving information on general pesticide awareness, the public should be made aware of the need to protect environmentally sensitive areas from pesticide misuse. Radio is an extremely effective medium in this regard, and should be utilized to its fullest.

Recommendation 16. It is recommended that training courses be designed and developed for health personnel in areas where pesticides are used frequently.

This SEA supports this recommendation and advocates inter-governmental collaboration in training programs.

Recommendation 17. It is recommended that each health center and dispensary located in an area where pesticides are used be provided with posters describing diagnosis and treatment of pesticide poisonings, as well as medicines and antidotes required for treatment of poisoning cases.

This SEA supports this recommendation, and advocates collaboration between the PPS and the Ministry of Health in appropriate implementation.

Recommendation 18. It is recommended that presently available tests for monitoring human exposure to pesticides should be implemented in the field. This includes measurement of cholinesterase levels in blood as a screening and indicator test for pesticide handlers and applicators.

This SEA supports the need to monitor the health of pesticide applicators and handlers during control operations. It is especially feasible to monitor blood cholinesterase in individuals working with organophosphate pesticides. This should be implemented on a regular basis with pesticide handlers and applicators. In addition, this SEA favors behavioral monitoring for symptoms of pesticide exposure.

PESTICIDE FORMULATION AND MANAGEMENT

Recommendation 19. It is recommended that the specifications for USAID purchase of locust/grasshopper insecticides be adapted for all insecticides.

This is an AID/W activity that should be implemented through a revision of USAID's Pest Management Guidelines that was developed in 1991. No Malawi-specific recommendation is included in this SEA as it is a central and regional activity.

Recommendation 20. It is recommended that pesticide container specifications be developed.

This is an AID/W activity that should be implemented through a revision of USAID's Pest Management Guidelines. USAID is working with the USEPA Pesticide Disposal Workgroup to achieve state-of-the-art pesticide container specifications.

BIOLOGICAL CONTROL

Recommendation 21. It is recommended that <u>Beauvaria</u> and other biological agents such as plant extracts be field tested under African and Asian conditions in priority countries.

AID/W is currently supporting research on bio-pesticides in Africa. The need for carefully controlled studies in the area of biological control is stressed by this SEA. Other areas of research should be pursued, especially in regard to native

populations of parasites, diseases and predators. USAID/Malawi may wish to support training and research in this subject area.

TRAINING

Recommendation 22. It is recommended that a comprehensive training program be developed for USAID Mission personnel who have responsibility for control operations. This will involve a review of existing materials and those under development, in order to save resources.

This SEA supports that recommendation for Malawi. The L/G Operations Handbook (USAID, 1989a) fills this need in part, as does the PEA and this SEA. Other materials include regional meetings and workshops, and short-term technical assistance.

Recommendation 23. It is recommended that local programs of training be instituted for pesticide storage management, environmental monitoring and public health (see Recommendation 16).

This SEA supports this recommendation, and recommends that high priority be given to training on the safe and appropriate application of pesticides. Training can take the form of courses, as well having as individuals work with outside technical expertise. "Train the trainer" programs are especially effective in passing information with minimal expense.

Recommendation 24. It is recommended that when technical assistance teams are provided they be given short-term intensive technical training (including language if necessary) and some background in the use and availability of training aids.

This SEA supports that recommendation as an AID/W activity. The overall preference is to have technical assistance teams with the needed technical expertise and sufficient language fluency for the tasks to be performed.

ECONOMICS

Recommendation 25. It is recommended that field research be carried out to generate badly needed economic data on a country-by-country basis.

This SEA supports this recommendation. Implementation in Malawi might consist of an agricultural productivity analysis along with an annual agricultural database program. This should include a research study on crop loss analysis. Information generated by the donor-funded FAO economic analysis studies could be useful in determining/interpreting/understanding the situation in the host country.

Recommendation 26. It is recommended that no pesticide be applied unless the provisional economic threshold of locusts or grasshoppers is exceeded.

Due to the erratic nature of these insects, along with potential for social impact, a valid intervention (economic) threshold will require both the long-term collection of quantitative data, and research to determine the extent to which agricultural productivity is threatened. In this light, it is important that intervention decisions, especially those involving pesticides, are supported by valid professional judgement. This would ensure minimum pesticide procurement by limiting USAID participation when a reasonable probability of substantial threat to crops does not exist.

ENVIRONMENTAL POLICY

Recommendation 27. It is recommended that USAID provide assistance to host countries in drawing up regulations on registration and management of pesticides and the drafting of environmental policy.

This SEA supports that recommendation. AID/W and USEPA are developing an assistance program to assist with pesticide regulations and policies, including human safety, environmental impact, and use, storage, and disposal. Implementation should include improvement of pesticide labeling, including clear precautionary statements, specific use directions, and appropriate instructions for disposal of empty containers. In addition, policy must include an environmental monitoring program, with results used in the planning of future pesticide use operations, as well as detection of possible misuse or unexpected adverse results.

PESTICIDE USE POLICY

Recommendation 28. It is recommended that a pesticide use inventory covering all treatments in both agricultural and health programs be developed, on a country-by-country basis.

This SEA supports that recommendation, and considers this to be a topic appropriate for GOM action. Such a pesticide inventory program, done in conjunction with good storage management, can prevent the build-up of obsolete stocks, and thereby reduce overall operations and storage costs.

PESTICIDE HANDBOOK

Recommendation 29. It is recommended the USAID produce a regularly updated pesticide handbook for use by its staff.

This SEA supports that recommendation as an AID/W or REDSO activity. Among the relevant activities in this area are USAID policies concerning pesticide use, efficacy and agricultural productivity, environmental impacts and health effects, and safety and mitigative measures. The Handbook should contain health, safety, and environmental assessments of pesticides that are likely to be used in Malawi.

SUPPORT AND TRAINING

Recommendation 30. It is recommended that technical assistance, education and training, and equipment be provided crop protection services of host countries with a view to making the services eventually self-sustaining.

This SEA supports this recommendation, but only with a thorough analysis of actual needs, existing supportive infrastructure, and the ability of the PPS to manage a sustainable program.

STORAGE

Recommendation 31. It is recommended that more pesticide storage facilities be built. Until that occurs, emergency supplies should be pre-positioned in the United States.

This SEA supports this recommendation in principle, and considers this a valid activity for Malawi. Due to inadequate storage facilities that currently exist in Malawi, support is for the Pesticide Bank concept. This SEA urges that the MOA look into improving storage conditions in the country. A thorough evaluation of storage facilities should be completed prior to project assistance.

FORECASTING

Recommendation 32. It is recommended that USAID make the decision whether to continue funding forecasting and remote sensing or to use FAO's early warning program.

This SEA is in favor of continuing and improving forecasting as an AID/W or FAO activity.

PUBLIC HEALTH MONITORING AND STUDY

Recommendation 33. It is recommended that a series of epidemiological case-control studies, within the countries involved in locust and grasshopper control, should be implemented in areas of heavy human exposure to pesticides.

Although this is a valid activity for Malawi, a lack of supportive infrastructure would require that such a research program be accomplished with outside expertise and facilities. However, it should be noted that the involvement of both MOA and MOH is vital for the success of this activity.

RESEARCH

Recommendation 34. It is recommended that applied research be carried out on the efficacy of various pesticides and insect growth retardants and their application.

This SEA supports this recommendation, including the search for other microbial pathogens of locust and grasshopper species as a longer term priority (see Rec. 21).

Recommendation 35. It is recommended that applied research be carried out on the use of plant extracts as anti-feedants.

Several plant extracts in Malawi are worth investigating for bio-pesticide activity, thus deserving additional field research.

As additional funds are available, the most promising options should be pursued.

Recommendation 36. It is recommended that research be carried out to determine the best techniques for assessing the impacts of organophosphates used for locust and grasshopper control in relation to the use of these and other chemicals for other pest control programs.

This SEA considers such comparative impact research an appropriate AID/W activity. A major international research effort has been launched in Senegal on the ecotoxicological effects of locust insecticides.

ENHANCING AND ACCELERATING IMPLEMENTATION

Recommendation 37. It is recommended that USAID, on the basis of the previous recommendations, develop a plan of action with practical procedures to provide guidance in locust/grasshopper control to missions in the field.

This SEA supports this recommendation. AID/W has a general plan of action that includes the development of Supplementary Environmental Assessments in the countries that are most critical for locust and grasshopper control. These countries include Botswana, Burkina Faso, Cameroon, Chad, Eritrea, Ethiopia, The Gambia, Kenya, Madagascar, Mali, Mauritania, Mozambique, Niger, Senegal, Somalia, Sudan, Tanzania, and now Malawi. These SEAs will, in turn, contain commitments for future actions. Country-specific plans of action will be developed to implement those commitments when needed. The country-specific plans of action, in conjunction with this SEA, will be the backbone for guidance of locust/grasshopper control activities.

Recommendation 38. It is recommended that detailed guidelines be developed for USAID to promote common approaches to locust and grasshopper control and safe pesticide use among UN Agencies and donor nations. Coordination of efforts is becoming increasingly important because of the increasing number and magnitude of multilateral agreements and follow up efforts in subsequent years by various donors.

This SEA supports this recommendation. Coordination must occur both at the AID/W level and the USAID/Malawi level. In Malawi, the PPS would not be the major coordinating body, and

donors need to discuss specific plans with each other. These efforts should be improved for the future.

APPENDIX C

RED LOCUST MONITORING AND TREATMENT REPORTS
FEBRUARY 1997

APPENDIX D

RED LOCUST AERIAL OPERATIONS USING MAKANDI AVIATION AIRCRAFT, OCTOBER 1996

APPENDIX E

IRLCO - CSA PEST SITUATION REPORT, NOVEMBER 1996

APPENDIX F

RELEVANT DOCUMENTATION

FAO Pesticide Management Documents:

a) International Code of Conduct for Distribution and Utilization of Pesticides.

b) Guidelines for safe pesticide distribution, storage, and handling.

c) Guidelines for pesticide disposal and container disposal.

d) List of FAO approved pesticides.

e) Pesticide storage and packaging guidelines.

f) Guidelines for pesticide approval and management.

g) Ecotoxicological guidelines.

h) Ground and aerial application guidelines.

i)Insecticide poisoning: prevention, diagnosis and treatment.

j) Guidelines for effective labeling.

k) Efficacy requirements for pesticide approval.

Other Documents on Pesticides and Locust/Grasshopper control:

a) Guidelines for selection, procurement, and use of pesticides in World Bank-financed projects.

b) Crop Protection Service Organization (D.310) T. 1. PRIFAS. Dec. 1988.

c) Effectiveness of localized pesticide treatment. (D.309) T. 2. PRIFAS - Dec. 1988.

d) Effects of locust and grasshopper control on the environment. (D. 308) T. 3. PRIFAS - Dec. 1988.

e) Locust and Grasshopper Control - Interministerial Instruction No. 3 related to protection of man and environment. Algérien doc.- March 1989.

f) First aid in cases of poisoning by locust and grasshopper control products. CIBA-GEIGY.

USEPA Pesticide Fact Sheets:

Acephate	# 140	October	1987
Bendiocarb	# 195	June	1987
Carbaryl	# 21	March	1984
Cholpyrophos	# 37	September	1984
Diazinon	# 96.1	December	1988
Fenitrothion	# 142	July	1987
Malathion	# 152	January	1987
Lindane	# 73	September	1985

These are among the many Pesticide Fact Sheets issued by the U.S. Environmental Protection Agency, selected for relevance to locust and grasshopper control. They summarize data known to USEPA at the time of preparation of the Fact Sheet. They generally include information on acute and chronic toxicity to humans and other non-target organisms, handling precautions, and other instructions for use. They may be requested from:

Office of Pesticide Programs
US Environmental Protection Agency
401 M Street, SW
Washington, DC 20460 USA

APPENDIX G

CABLE OF UPDATE ON AID-APPROVED LIST OF PESTICIDES FOR LOCUST/GRASSHOPPER CONTROL

Figure 6. National Parks and Wildlife Reserves

Majete Wildlife Reserve (69,100 ha) is on the spectacular waterfalls of the lower Shire River.

Mwabvi Wildlife Reserve (8700 ha) borders on Mozambique. Its hills and rocky gorges support antelope species, leopards, and antelope.

Animal biodiversity in Malawi is high with 163 mammal species, 620 birds, 92 reptiles, 538 fish, and 54 amphibians. The parks, and reserves are habitat for a wide variety of plains and forest mammals, ranging from herbivores such as various antelopes, zebras, elephants, rhinos, and buffaloes to predators like lions, cheetahs, and various wild cats. The Shire River wetlands and the lake shoreline plains are important to a diverse and abundant bird fauna. It is critical to consider the importance of these habitats, and the direct vulnerability of birds to pesticide toxicity, in implementing any locust or grasshopper control operations involving pesticide spraying.

As Red Locust breeding is wetland-associated, this SEA recommends considerable restraint, careful monitoring and targeting, and avoidance of the commonly-used Fenitrothion should control operations in the south of Malawi be necessary.

Forest reserves cover 980,000 ha, and have been established to protect watersheds and fragile areas, particularly areas subject to erosion. They are administered by the Ministry of Forestry, Fisheries, and Environmental Affairs (MFFEA), but receive limited protection due to lack of staff and resources.

Protected areas should be surrounded by buffer zones at least 2-2.5 km wide. These are needed to avoid accidental pesticide application and possible spray drift, and will help to minimize indirect effects of pesticide use. Within buffer zones, higher priority should be given to use of alternatives to chemical pesticides, and a monitoring program so that non-chemical alternatives can be applied successfully. As the capacity of the PPS to provide training in non-chemical alternatives increases, the width of the buffer zones can be decreased.

4.2 Non-Protected Sensitive Areas

In addition to these protected areas, the PPS should take precautions in a number of other areas that have a lower level of vulnerability, but which are still ecologically sensitive. Wetlands and other aquatic ecosystems are particularly fragile, and many of the officially protected areas are not self-

sufficient ecosystems, with wildlife moving in and out seasonally. The wildlife movement corridors need to be considered, as do regions outside the park and reserve system which also harbor considerable wildlife. These areas can be designated as high priority areas for Village Brigade mobilization, intensive monitoring, and encouraging non-chemical methods of control. The areas would also include buffer zones around all territories designated above as fully protected zones, given their sensitivity to indirect effects.

The implementation of fragile area protection programs must lie with the GOM itself. Enforcement of regulations to ensure sensitive areas are actually protected to the ultimate benefit of the people of Malawi, and must therefore be made a priority. The effectiveness of protection programs is closely linked with integration of local populations to build a feeling of responsibility. Donors should monitor the protection program, assisting it if necessary, and they may even wish to base funding levels on the level of GOM commitment for environmental protection.

4.3 Protected Animals and Plants

Numerous plant and animal species are listed as endangered or threatened in Malawi. **Rather than listing these species here, it should be sufficient to articulate to GOM and the donor community that no U.S.-funded pesticides will be applied or related operations take place in or around established critical habitat.**

Many populations of endangered and threatened species continue to decline despite legislation. Several animal species may cease to exist unless a considerably higher level of protection can be brought to bear. Any U.S.-funded operation must consider the potential impact of pesticides on these already strained habitats and the flora and fauna contained therein. While the value of human life cannot be placed below that of an endangered species, the U.S. should not allow itself to be drawn into a situation that may force such a choice. Here again, early survey and surgical treatment programs can allay such situations.

4.4 Pesticide Alternatives in Sensitive Areas

Farmers living in areas which have been designated as environmentally sensitive should receive training in IPM and the use of control methods which do not use chemical pesticides. These farmers should be encouraged to use traditional methods and should be informed as to how pesticides are dangerous to both

humans and the environment. Farmers in such areas should be given individual attention, time to ask questions, and opportunity for discussion. PPS trainers should have a basic knowledge concerning food chains and the indirect effects of pesticides.