



AA-175-8/16

## Consortium for International Crop Protection

4321 Hartwick Road, Suite 404, College Park, Maryland 20740 USA  
Telephone: (301) 403-4223  Cable: CONSORTICP  
Telex: 5106013963  FAX: (301) 403-4226

74503

### ENVIRONMENTAL ASSESSMENT OF THE MOROCCO LOCUST CONTROL PROJECT

608-0196

#### INTEGRATED PEST MANAGEMENT AND ENVIRONMENTAL PROTECTION PROJECT

**Contract No.**  
**DAN-4142-C-00-5122-00**  
**Project No. 936-4142**

United States Agency for International Development  
Mission to Morocco  
Rabat, Morocco

May 1988

## TABLE OF CONTENTS

Cover Page. . . . .	1
Table of Contents . . . . .	11
List of Acronyms and Abbreviations. . . . .	1v

<u>Section</u>	<u>Page</u>
1.0 EXECUTIVE SUMMARY. . . . .	1-1
2.0 APPLICABLE ENVIRONMENTAL PROCEDURES AND PURPOSE OF ASSESSMENT. . . . .	2-1
2.1 AID Environmental Procedures. . . . .	2-1
2.2 Programmatic Environmental Assessment for Locust Control. . . . .	2-1
2.3 Government of Morocco Environmental/Pesticide Legislation . . . . .	2-2
3.0 SCOPING PROCEDURE. . . . .	3-1
4.0 PROJECT DESCRIPTION. . . . .	4-1
4.1 Background, Goal, Purpose and Outputs . . . . .	4-1
4.1.1 Background . . . . .	4-1
4.1.2 Project Goal, Purpose and Outputs. . . . .	4-2
4.2 Other Donor Activities. . . . .	4-2
4.3 Analysis of Alternatives. . . . .	4-2
4.4 Affected Environment. . . . .	4-3
4.4.1 Land Utilization and Agricultural Resources. . . . .	4-3
4.4.2 Forestry Resources . . . . .	4-4
4.4.3 Parks and Protected Areas. . . . .	4-4
4.4.4 Rare and Endangered and/or Migratory Species . . . . .	4-5
4.4.5 Human Population . . . . .	4-6
5.0 PESTICIDE USE ASSESSMENT . . . . .	5-1
5.1 Basis for Selection of Insecticides for Locust Control and U.S. EPA Registration Status of the Selected Insecticides . . . . .	5-1
5.1.1 Field Testing Programs . . . . .	5-1
5.1.2 Recommendations of the L/G PEA . . . . .	5-2
5.1.3 Selection of Insecticides for the Morocco Program. . . . .	5-3
5.2 Integrated Pest Management and Locust Control in Morocco. . . . .	5-4
5.3 Application Methods and Equipment . . . . .	5-5
5.4 Acute and Long-term Environmental/Toxicological Hazards . . . . .	5-5
5.5 Efficacy of Selected Insecticides for Locust Control. . . . .	5-6
5.6 Effect of Selected Insecticides on Non-target Organisms and the Natural Environment . . . . .	5-6
5.7 Conditions Under Which Insecticides Are to Be Used. . . . .	5-7
5.8 Availability and Effectiveness of Other Insecticides and/or Non-chemical Control Measures. . . . .	5-8
5.9 Ability of the Government of Morocco to Regulate or Control the Distribution, Storage, Use and Disposal of Pesticides . . . . .	5-8
5.10 Provisions for Training Locust Control Insecticide Users. . . . .	5-10
5.11 Provisions for Monitoring the Use and Efficacy of the Selected Insecticides . . . . .	5-11

- 6.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION . . . . . 6-1
  - 6.1 Unavoidable Adverse Environmental Effects . . . . . 6-1
  - 6.2 Relationship Between Short-term Impacts and Long-Term Productivity. . . . . 6-1
  - 6.3 Irreversible or Irretrievable Commitments of Resources. . . . . 6-1
- 7.0 MITIGATION OF ENVIRONMENTAL IMPACTS. . . . . 7-1
  - 7.1 Environmental/Health/Safety Technical Assistance, Commodities, and Equipment. . . . . 7-1
    - 7.1.1 Entomologist/Environmental Monitoring Specialist . . . . . 7-1
    - 7.1.2 Pesticide Management and Health/Safety Specialist. . . . . 7-2
    - 7.1.3 Cholinesterase Monitoring Test Kits. . . . . 7-3
    - 7.1.4 Clothing and Personal Protective Equipment . . . . . 7-3
  - 7.2 Insecticide Application in Ecologically Sensitive Areas . . . . . 7-3
  - 7.3 Management of Locust Control Insecticide Drums. . . . . 7-4
- 8.0 LIST OF PREPARERS. . . . . 8-1
- 9.0 REFERENCES . . . . . 9-1

APPENDICES

- A. Persons Contacted. . . . . A-1
- B. Recommended Technical Assistance and Commodities for Mitigation of Environmental and Health/Safety Impacts. . . . . B-1

## LIST OF ABBREVIATIONS AND DEFINITIONS

AID	- U.S. Agency for International Development (Washington)
ALIC	- Arid Lands Information Center, University of Arizona
CICP	- Consortium for International Crop Protection
CFR	- U.S. Code of Federal Regulations
deg	- degree
EA	- environmental assessment
EPA	- U.S. Environmental Protection Agency
FAO	- Food and Agriculture Organization
ft	- foot
gal	- gallon (US)
GOM	- Government of Morocco
ha	- hectare
IPM	- integrated pest management
IUCN	- International Union for the Conservation of Nature and Natural Resources
kg	- kilogram
km	- kilometer
l	- liters
L/G	- locust/grasshopper
L/G PEA	- Programmatic Environmental Assessment for Locust and Grasshopper Control in Africa and Asia (TAMS/CICP, 1988)
m	- meter
min	- minute
ml	- milliliter
mm	- millimeter

- MOPH - Ministry of Public Health
- N - north
- PEA - Programmatic Environmental Assessment
- PPS - Plant Protection Service
- ULV - ultra-low volume application of pesticide - less than 2 liters per hectare
- U.S. - United States of America
- USAID - AID Mission to Morocco
- USG - Government of the United States
- W - west
- waddi - intermittent stream bed
- WHO - World Health Organization

## 1.0 EXECUTIVE SUMMARY

USAID/Morocco intends to develop and implement a project to provide programmatic assistance on an urgent basis to the Kingdom of Morocco's Desert Locust Control Campaign. USAID's assistance will be in the form of a comprehensive package of commodities and services which will aid the Government of Morocco (GOM) in meeting the demands of the immediate crisis as well as strengthen its institutional capacity to maintain longer term control of the locust outbreak. (Section 4.1).

This environmental assessment (EA) was prepared as a critical element of the project design, in compliance with AID's environmental procedures at 22 CFR 216. The EA identifies and analyzes the environmental and health/safety issues specific to the proposed project. The Programmatic Environmental Assessment (PEA) of Locust and Grasshopper Control in Africa and Asia (TAMS/CICP, 1988) forms the technical basis for the findings and recommendations of this EA, including a determination of the scope of the technical and policy issues to be examined in assessing the environmental impacts of large-scale use of insecticides for control of locusts in Morocco. (Sections 2.0 and 3.0).

The preferred alternative among the candidate technical approaches was determined to be chemical (insecticide) control in the context of a judicious and well-managed application program. (Section 4.3).

Morocco has a rich and diverse flora and fauna. There are a number of legally protected nature reserves and/or ecologically sensitive areas in the locust infestation zone, which must receive special consideration in the decision-making process leading to treatment for locusts. (Section 4.4).

The following insecticides are provisionally approved for AID-funded procurement and/or use in the Morocco locust control program, subject to the final findings of the Locust/Grasshopper PEA: carbaryl, malathion, fenitrothion (use only), bendiocarb, chlorpyrifos, lambda-cyhalothrin, and tralomethrin. (Section 5.1).

The GOM has in place a strong institutional structure for managing the locust control program, the effectiveness of which could be enhanced by interaction with expert counterparts through the provision of specialized technical assistance. (Section 5.9).

Required environmental mitigation measures under the project include provision of specialized technical expertise in the areas of pre- and post-treatment environmental monitoring, pesticide management and health/safety. Health and safety related commodities to be provided include protective clothing and equipment and test kits for monitoring worker exposure to insecticides. Other critical mitigation measures include special procedures for locust control in ecologically sensitive areas, and disposal of empty insecticide drums. (Section 7.0 and Appendix B).

## 2.0 APPLICABLE ENVIRONMENTAL PROCEDURES AND PURPOSE OF ASSESSMENT

The Morocco Locust Control Project will provide technical assistance, aerial application services, commodities, equipment and insecticides to assist the GOM in controlling the current series of severe desert locust outbreaks and in preventing or minimizing attendant crop damage due to locust infestations. Given that a significant amount of the technical assistance and commodities to be provided under the project are related to the mitigation of potential adverse environmental impacts of both this project and in GOM's overall locust control program, the findings of this environmental assessment are an important element of the project design. This environmental assessment was prepared on site at USAID/Morocco as an element of the overall locust control project design during March-April 1988. Due to the unexpected major locust outbreak in Morocco during this time, the project design and authorization process was accelerated in order to allow timely response to the crisis. To gather information for the environmental assessment, the Locust Control project design team conducted extensive interviews of GOM officials in charge of the national locust control effort as well as those responsible for environmental protection and public health; observed control campaign sites and ongoing operations; and inspected the facilities of these and related GOM entities.

### 2.1 AID ENVIRONMENTAL PROCEDURES

It is AID policy to ensure that the environmental consequences of AID-financed activities are identified and considered by AID and the host country prior to a final decision to proceed and that appropriate environmental safeguards are adopted (AID, 1980). This policy is embodied in the legal requirements set forth at Title 22 of the Code of Federal Regulations, Part 216, "A.I.D. Environmental Procedures" (22 CFR 216). The environmental assessment (EA) for the Morocco Locust Control Project is based on the requirements of 22 CFR 216. In view of the fact that the proposed project will provide chemical insecticides for locust control, the EA for this project also includes (Section 5.0) the analyses required under AID's pesticide procedures at 22 CFR 216.3(b). The environmental assessment factors these criteria into the identification, evaluation, analysis, and recommended mitigation of probable environmental impacts of the proposed project.

### 2.2 PROGRAMMATIC ENVIRONMENTAL ASSESSMENT FOR LOCUST CONTROL

In early 1987 AID initiated a number of activities related to implementation of its commitment to the use of environmentally acceptable pesticides in locust/grasshopper (L/G) control programs in Africa and Asia, including preparation of a programmatic environmental assessment (PEA) per 22 CFR 216.6(d) of L/G control in Africa and Asia; and staging of a field testing program to study the efficacy and environmental impacts of certain pesticides for the control of locusts and grasshoppers in Africa (AID, 1987). Draft reports resulting from these two activities were available at the time of preparation of this EA, and provided the technical background for many of the findings and recommendations contained herein.

One of the purposes of a programmatic environmental assessment is to carry out a scoping process to identify and examine the underlying technical concerns and environmental issues generic to a particular activity on a regional basis, thus allowing an environmental assessment of the same activity in an individual country to focus on the country-specific environmental issues and impacts which were not evaluated in the PEA. In particular, the Programmatic Environmental Assessment for Locust and Grasshopper Control in Africa and Asia (L/G PEA) prepared by TAMS, Inc. and the Consortium for International Crop Protection (TAMS/CICP, 1988), for AID's Africa and Asia/Near East regional bureaus serves as the basis for this Morocco-specific EA. Accordingly, the findings and conclusions of the L/G PEA are incorporated by reference into this EA, and the PEA will be cited in the text of this document where appropriate in order to avoid unnecessary duplication of material. It should be noted that the L/G PEA was in draft final form and under AID review at the time of preparation of the Morocco Locust Control EA. Given that the conclusions and recommendations of the PEA are subject to revision as a result of the review process, any changes in the PEA affecting the conclusions of the Morocco EA will need to be addressed following finalization of the PEA. It is not anticipated at this time that any of the principal findings of the Morocco EA will be substantively affected by the outcome of the L/G PEA review.

The purpose of environmental assessments, whether programmatic or country-specific, is to provide AID and host country decision makers with a full discussion of the significant environmental effects of a proposed action so that the expected benefits of development objectives can be weighed against any adverse impacts on the human environment. In view of this important function of environmental assessments, both the L/G PEA and the Morocco Locust Control EA will be translated into French in order to insure that all CCM agencies concerned with the locust control effort will have ready access to the findings, conclusions, and recommendations of these studies.

### 2.3 GOVERNMENT OF MOROCCO ENVIRONMENTAL/PESTICIDE LEGISLATION

The GOM has promulgated laws and other regulatory instruments for the protection of air and water quality (including seawater pollution); soil conservation; wildlife conservation; solid waste disposal; importation, sale, and use of toxic substances; and urban land use planning (ALIC, 1980). There are apparently no regulations requiring formal environmental review of major actions, either private or public sector, with the potential for impact on the environment.

The rules on importation, sale, and use of toxic substances (including pesticides) consist of a complex web of laws, regulations, and administrative decrees, many of which date back to the 1920's and '30's and are therefore clearly outdated from a technical standpoint. Regarding pesticides in particular, the GOM Plant Protection Service (PPS) (which is responsible for regulating pesticides in Morocco) is currently engaged in a regulatory development effort to streamline, revise, and update the regulations governing pesticides (see Section 5.9).

### 3.0 SCOPING PROCEDURE

A.I.D. Environmental Procedures at 22 CFR 216.3(a)(4) describe the scoping process to be employed in identifying the significant issues related to a proposed project and determining the scope of the issues to be addressed in the environmental assessment. Critical elements of the scoping process include: a determination of the scope and significance of the issues to be analysed in the EA, and identification of and elimination from detailed study those issues that are not significant or have been covered by earlier environmental review.

The process of identifying the technical and policy issues applicable to control of large scale locust outbreaks which require detailed environmental review was performed during preparation of the L/G PEA (TAMS/CICP, 1988), and will not be repeated here. The principal Morocco-specific issues requiring detailed examination are treated in the pesticide use assessment (Section 5.0). Since preparation of this EA occurred during an ongoing emergency operation, it was not feasible to stage a "scoping session" of the type normally held for projects with the potential for significant environmental impacts, due to the fact that most of the GOM personnel responsible for Morocco's locust control program were traveling heavily or on temporary assignment to field posts to manage the operation. Therefore, a modified scoping procedure based on an individual consultative approach was adopted. A list of key people contacted in this process is provided in Appendix A.

Meetings to discuss and identify the potential environmental impacts of the proposed project as well as recommended mitigation actions were held with the Ministry of Agriculture Crop Protection Service, Ministry of Public Health Environmental Health Service, and Food and Agriculture Organization Morocco Country Office.

## 4.0 PROJECT DESCRIPTION

### 4.1 BACKGROUND, GOAL, PURPOSE AND OUTPUTS

#### 4.1.1 Background

For the first time in twenty years, in 1987, desert locusts (Schistocerca gregoria) entered Morocco, threatening disaster and significant agricultural losses. Swarms of desert locusts, which had migrated from Chad, invaded Niger in early summer, 1987. Breeding occurred and a large new generation was produced. At the same time, locust hatching was apparently taking place in Northern Mali, Mauritania, and Southern Algeria. In October, massive swarms of locusts moved northwest across the Sahara on a vast front. Swarms moved into eastern Morocco where they were first sighted in late October.

As a consequence of the severity of the influx of locusts and their threat to agriculture, on November 4, 1987 the Government of Morocco (GOM) requested that USAID provide emergency assistance. On November 9, 1987, two American aircraft were moved from Dakar, Senegal to Guelmim, Morocco. A shipment of 40,000 liters of malathion insecticide was air-lifted from the United States to Agadir shortly thereafter. Technical assistance was provided to support the operation and assist the GOM to assess the biological aspects of the locust infestation and advise on spray operations. The USAID aircraft operation was assisted by AID-funded ground to air communication radios and strobe lights. Protective clothing and motor pumps (used to transfer malathion from barrels to planes) were also provided by USAID. The total amount of AID support was \$650,000. Due to the prediction by entomologists that the locust threat would repeat itself during October, 1988 and possibly October, 1989, and due to the GOM's expressed need for further support, a decision was made to design a longer term bilateral project to assist the GOM with a locust control strategy. Subsequent to this, Morocco again suffered an unexpected locust attack of plague proportions. The Mission turned to AID/Washington for assistance. The emergency is expected to last until the end of June, 1988. During this period, OFDA will procure for Morocco 100,000 liters of malathion, 183,000 litres of carbaryl, test kits for pesticide contamination, radios, field marking devices, and 2 turbo thrush aircraft which began operating March 27 and will continue until the end of the current emergency.

Indications are that the desert locust will return to Morocco in potentially plague proportions in October 1988 and create problems until January 1989. Depending on the success of control procedures, the locust could again return in March to June 1989, and again in October 1989 and March 1990. There is a possibility that the locust problem could continue over the next seven to eight years. The proposed project would address the medium term outlook, beginning for the October 1988 invasion and allowing flexibility for future U.S. support for the GOM control efforts over the period until the project's PACD of September 30, 1990.

#### 4.1.2 Project Goal, Purpose, and Output

The goal of the proposed Morocco Locust Control Project is to save agricultural and livestock production from physical destruction in order to avert enormous monetary losses. The specific purpose of the project is to assist the GOM in controlling the desert locust. The project will provide technical assistance, aerial application flight hours, commodities, equipment, and insecticides to assist the GOM in its locust control program. Based on the projected strategy, the project will fund the following technical assistance: a project management coordinator, a logistical operations specialist, an entomologist/ecologist, a pesticide management and health/safety specialist, and a spray calibration specialist.

The outputs of the project include: (1) the control and destruction of desert locust swarms (the number of hectares treated will be programmed at the time of the infestation and will depend upon the total magnitude of the infestation as well as the assistance being provided by other donors); (2) the equipping of GOM helicopters with insecticide application systems and calibration of the systems; (3) the training of GOM personnel in the proper management, handling, and use of locust control insecticides and the provision of pesticide safety equipment; and (4) the provision of specialized technical assistance to enhance the GOM's capability to assess the extent of the locust infestation and to develop and implement an appropriate response.

#### 4.2 OTHER DONOR ACTIVITIES

A number of other donors, both bilateral and multilateral, are assisting the GOM in its locust control program. The bulk of this assistance is in the form of insecticides and aerial treatment services. Several donors have provided protective clothing and equipment as well as other commodities such as vehicles. Only limited amounts of technical assistance have been provided by donors other than USAID. The proposed project would be the first and only donor effort to contribute a comprehensive package of commodities and services to Morocco's locust control program.

#### 4.3 ANALYSIS OF ALTERNATIVES

The L/G PEA (TAMS/CICP, 1988) contains a detailed analysis of five technical alternatives considered by AID for locust and grasshopper control:

- No action
- Non-chemical control (i.e., mechanical destruction or changes in cultural practices)
- Biological control
- Chemical control
- Integrated pest management (IPM)

For each of the technical alternatives, the L/G PEA analysis considered environmental impact; costs; short, medium, and long-term actions; effectiveness; training requirements; research requirements; and recommended environmental mitigations. The alternatives analysis concluded that:

The technical alternatives are theoretical rather than actual. There are, at the present time, only two alternatives -- that of taking no action, or of mounting a control effort using chemical control. If control is chosen, then the technical alternatives really come down to different approaches within the chemical control operation: either that of large scale spraying of extensive areas, as was adopted in [the African grasshopper campaign of] 1986, or more selective spraying of carefully targeted outbreak areas. The latter presents less potentially harmful environmental consequences, as well as being the more cost-effective approach (TAMS/CICP, 1988).

The situation in Morocco warrants a similar conclusion (Section 4.1). Selective aerial treatment in the context of a well-managed and technically sound control program is the preferred alternative of the Morocco Locust Control Project, and will be the focus of this EA.

#### 4.4 AFFECTED ENVIRONMENT

The Kingdom of Morocco lies at the northwest corner of the African continent, bordered on the north and west by the Mediterranean Sea and the Atlantic Ocean, respectively, and on the east and south by Algeria and Mauritania, respectively. Morocco covers an area of approximately 500,000 square kilometers (193,000 square miles), including the territory of the former Spanish Sahara, which is claimed and controlled by Morocco. Morocco is divided into two distinct topographic regions, the coastal plains in the northwest, and the mountains and arid plateaus in the east and south. The fertile coastal plains are separated from the economically poorer arid plateaus by a series of mountain ranges, including the High Atlas, Middle Atlas, and Rif Massif systems. The agriculturally rich coastal plains are the most densely populated and most economically advanced. South and southeast of the mountain systems, the arid plateaus gradually converge with the Sahara desert (ALIC, 1980).

##### 4.4.1 Land Utilization and Agricultural Resources (USAID/Morocco, 1986)

Morocco has an essentially arid or semi-arid climate, with moderate winters and dry summers. Most of the precipitation occurs between October and April, with very little rainfall between June and September. Only 8.3 million hectares (12 percent) of Morocco's 69 million hectares (ha) of land (excluding the Sahara) have adequate soils and sufficient rainfall for crop production. Another 41.6 percent of Morocco's land (28.7 million ha) consists of semi-arid and forest regions, suitable only for grazing. Between 40 and 50 percent of the cultivable land receives an erratic rainfall averaging less than 400 mm. The distribution of rains during the agricultural cycle varies such that

aggregate production levels fluctuate significantly - at least 35-40 percent around the long term average.

Nearly 2 million households (40 percent of the labor force) are dependent on agriculture, making this sector critical to Morocco. Approximately 51 percent of the agricultural households rely on rainfed agriculture (often associated with animal husbandry); 18 percent depends solely on livestock production; 26 percent depends on irrigated agriculture; and 5 percent depends on forestry and other miscellaneous activities. Crop production in Morocco is narrowly focused. In recent years cereals have been planted on approximately half of the cultivated land (including irrigated land), other crops on 20 percent of the land, with the remainder lying fallow. Fruits, vegetables, forage crops, and industrial crops are grown in irrigated regions. Livestock production represents 36 percent of gross agricultural production.

#### 4.4.2 Forestry Resources (USAID/Morocco, 1986; ALIC, 1980)

Forests cover about 5.2 million hectares, 360,000 ha of which is in plantations and the rest in natural growth. Another 2.6 million ha is covered with alfa grass (*Stipa tenacissima*). It is estimated that 2.4 million ha of forests (31 percent of the total) and 1 million ha of alfa grass (13 percent of the total) have some productive potential. The primary value of the remaining forest and grass land is in soil and watershed protection. The main forest producing areas in Morocco are east of the Rabat-Mohammedia region, the Middle Atlas and Rif mountains, and the Gharb Mamora forest near Kenitra. Alfa grass, which is used primarily for the production of paper and for forage, grows primarily in the northeastern part of the country.

#### 4.4.3 Parks and Protected Areas (ALIC, 1980; Drucker, 1987; Duvall, 1988)

Morocco has two established national parks and 13 other nature and/or wildlife preserves. All protected areas are administered by the Ministry of Agriculture. Day-to-day management is the responsibility of the Direction des Eaux et Forêts. None of the existing parks or protected areas currently meet international standards, but projects with various international organizations are assisting in the development of national park management plans and information centers, which should eventually result in some improvement in the overall situation. Design of any new parks will take international criteria into account. There are also a number of unprotected wetlands of biological importance, most of which are on the Atlantic and Mediterranean coasts. An important exception is the series of mountain lakes in the Middle Atlas, only one of which (Lac Affenourir) is protected. These lakes are permanent, and are of great importance for migratory and wintering waterfowl. Parks and/or protected areas that lie within regular desert locust breeding sites and migration corridors in Morocco are: Khnifiss reserve biologique, Bouarfa reserve de faune, and Iriki reserve de faune.

4.4.3.1 Khnifiss Reserve Biologique. This 6,500 ha reserve is situated on the southern portion of Morocco's Atlantic coast, 70 km north of Tarfaya and 120 km south of Tan Tan, in the province of Tarfaya

(28 deg 00 min N, 12 deg 25 min W). The site, which is an important shore bird habitat, consists of a large brackish lagoon with mudflats, sandy islets, and saline marshy areas. Military considerations restrict access by aircraft, and locust control measures in the vicinity of this reserve would be most likely consist of ground strip spraying for hopper band control.

4.4.3.2 Bouarfa Reserve de Faune. This large reserve (ca 220,000 ha) is located in eastern Morocco near the Algerian frontier, south of the town of Bouarfa (32 deg 25 min N, 02 deg 00 min W). This area, which is rich in saharan wildlife such as the dorcas gazelle and the houbara bustard, is situated on the Haut Plateau and has varied relief. Locust control in the vicinity of this reserve will be principally by means of aerial ULV spraying of insecticides.

4.4.3.3 Iriki Reserve de Faune. Iriki is in southern Morocco near the Algerian border (29 deg 50 min N, 05 deg 35 min W), and is comprised of temporary marshes in the oued Draa valley which are filled by the flood waters of the oued Draa after heavy rains. The climate is classified as arid Saharan, with less than 60 mm rain per year. The marshes can be completely dry for years when there is no rain. In wet years the area harbors large numbers of wintering waterfowl and breeding birds. The area to the west of the Iriki reserve is a major breeding area for locusts, and will undergo aerial treatment.

#### 4.4.4 Rare and Endangered and/or Migratory Species (ALIC, 1980; Duvall, 1988)

Definitive information on the current status of the flora and fauna of Morocco is not available. Very little is known about the distribution of endangered species within Morocco. The information provided below is based on best professional judgement. Habitat loss from overgrazing, depletion of forests, and other non-sustainable resource use leading to severe ecosystem degradation is known to be resulting in serious detrimental impacts on indigenous species, although the exact extent of these changes is undocumented. Morocco's coastal wetlands along the Mediterranean and the length of the Atlantic coast are a sensitive and extremely important habitat and/or flyway for migrating and wintering waterfowl from Europe, as well as several indigenous species.

4.4.4.1 Birds. Approximately 131 species of passerine birds are known to occur in Morocco, comprised of resident breeders, migrant breeders, occasional breeders, winter visitors, and accidental visitors. The species of birds which occur in the breeding or migrating areas for desert locusts, and which are considered to be rare or endangered are as follows: Tawny or Steppe Eagle (Aquila rapax); Golden Eagle (A. chrysaetos); Griffon Vulture (Gyps fulvus); White Stork (Ciconia ciconia); Red Kite (Milvus milvus); Bearded Vulture or Lammergier (Gypaetus barbatus); Peregrine Falcon (Falco peregrinus); Houbara Bustard (Chlamydotis undulata); Red-necked Nightjar (Caprimulgus ruficollis); Dark Chanting Goshawk (Melierax metabates); and Bald Ibis (Geronticus eremita).

4.4.4.2 Mammals. Morocco has 108 species of indigenous mammals, but the status of most of species is unknown. A number of these which may occur in the breeding and migrating areas of the desert locust are considered to be rare or endangered, including: Insectivores, four species; Rodentia, four species; carnivora, four species - Ruppel's Sand Fox (Lynx ruppelli), Striped Hyaena (Hyaena hyaena), Caracal (Felis caracal), and Cheeta (Acinonyx jubatus); and Artiodactyla, four species - Dorcas Gazelle (Gazella dorcas), Cuvier's Gazelle (Gazella cuvieri), Dama Gazelle (Gazella dama), and Barbary Sheep (Ammotragus lervia).

4.4.4.3 Plants. The identified species of Morocco's flora, which, with subspecies, number 4,200 (including 800 endemics) are both rich and diverse. Factors related to cultivation of marginal lands and severe overgrazing of almost all available land make it extremely difficult to determine the current state of indigenous flora. Some 34 of these species known at some time to occur in the areas likely to be treated for locusts are on the current list of rare and endangered Moroccan plant species compiled by the International Union for the Conservation of Nature and Natural Resources (IUCN).

#### 4.4.5 Human Population (ALIC, 1980; USDS, 1986)

The estimated 1984 population was 22.8 million, with an annual growth rate of 2.6 percent. Ethnically, the population is 99.1 percent Arab-Berber, and the urban sector constitutes over 40 percent. Most of the people live west of the High Atlas Mountains. All but one of the primary urban centers with a population of more than 100,000 are west of the Atlas, and most of these are coastal. All of the locust control operations will take place east of the Atlas mountains.

## 5.0 PESTICIDE USE ASSESSMENT

The format and content of this assessment is based on the requirements of 22 CFR 216.3(b)(1)(i) (AID, 1980). Much of the technical background for this assessment is available in the L/G PEA (TAMS/CICP, 1988) and in the report on AID's L/G control pesticide field testing program in Mali (Dynamac, 1988), and will not be repeated here. Citations to these documents will be made where appropriate, and the reader is referred to them for more detail.

### 5.1 BASIS FOR SELECTION OF INSECTICIDES FOR LOCUST CONTROL AND U.S. ENVIRONMENTAL PROTECTION AGENCY REGISTRATION STATUS OF THE SELECTED INSECTICIDES

#### 5.1.1 Field Testing Programs

AID is currently conducting a scientific program to study the efficacy and environmental impacts of certain pesticides for the control of locusts and grasshoppers in Africa (Dynamac, 1988). Rigorous efficacy and environmental impact field trials of eight insecticides have been conducted in Mali, against the Senegalese grasshopper, Oedaleus senegalensis. It is currently planned under this program to evaluate the same eight pesticides in two additional countries, against other grasshopper/locust species. The preliminary phase of the testing program consisted of a technical selection process to narrow the field of pesticides with potential for use in AID-funded L/G control projects to a list of candidate chemicals for which detailed field testing is considered appropriate. The classes of pesticides from which selections were made were organophosphorus compounds, carbamates, and pyrethroids. The primary criterion for selection was AID's policy that any AID-financed pesticide for locust/grasshopper control be registered with U.S. EPA and have a tolerance established for at least one food use (40 CFR 80), or meet the established acceptable daily intake level and maximum residue level recommended by the Joint Meeting on Pesticide Residues to the FAO/WHO Codex Committee on Pesticide Residues. Table 5-1 lists the insecticides selected for field testing on the basis of this policy requirement, and taking into consideration potential environmental impacts and efficacy as determined by literature reviews, balance among the three classes of pesticides to be evaluated, and product availability.

Table 5-1. Insecticides Selected for AID Field Testing Program.

<u>Organophosphates</u>	<u>Carbamates</u>	<u>Pyrethroids</u>
Malathion	Carbaryl	Lambda-cyhalothrin
Fenitrothion	Bendiocarb	Tralomethrin
Chlorpyrifos		
Diazinon		

The preliminary conclusions of the testing program based on the results of the Mali field trials showed all eight chemicals to be efficacious against the Senegalese grasshopper at the rates applied. The findings were inconclusive regarding effects on beneficial and non-target insects due to shortfalls and variability of test data. No impacts on birds, reptiles, and mammals were observed, but incomplete residue analysis precluded a full evaluation of the potential environmental impact of the insecticides. The lack of acute effects and preliminary evidence of rapid decomposition of the applied insecticides suggested that single applications in grassland or agricultural areas can be done safely (Dynamac, 1988).

In a separate study funded by FAO, Pinto, et al. (1988) performed an environmental assessment of fenitrothion use in the Sudan L/G control program, including efficacy/environmental impact field trials and residue studies of aerial ULV application. The results of this study indicated that fenitrothion, when applied at approved dosages according to standard protocols, was effective against the desert locust (Schistocerca gregaria). Significant effects on some nontarget organisms were observed. The assessment concluded that more study of such adverse effects is needed, and that use of fenitrothion in locust/grasshopper control programs must occur in the context of well-managed operations in order to minimize unavoidable impacts.

#### 5.1.2 Recommendations of the L/G Programmatic Environmental Assessment

The L/G PEA (TAMS/CICP, 1988) evaluated the eight insecticides listed above (among others) for efficacy and environmental soundness in L/G control based on available information (which, for the draft PEA, did not include the findings of the Mali or Sudan field tests). The preliminary conclusions of the L/G PEA regarding use of these eight chemicals in L/G programs are as follows (TAMS/CICP, 1988):

- Carbaryl - Appropriate for both aquatic and terrestrial applications (but not around pollinating insects)
- Diazinon - Use should be conditional on the outcome of a current U.S. EPA review of certain registered uses
- Fenitrothion - Use with caution in aquatic environments; not recommended for terrestrial use (due to toxicity to birds)
- Malathion - Use with caution in aquatic environments; appropriate for terrestrial application
- Bendiocarb - Appropriate for aquatic environments; use with caution in terrestrial application
- Chlorpyrifos - Use with caution in both aquatic and terrestrial application
- lambda-cyhalothrin - Appropriate for terrestrial use; not recommended for aquatic environments
- Tralomethrin - Appropriate for terrestrial use; not recommended for aquatic environments

### 5.1.3 Selection of Insecticides for the Morocco Locust Control Program

To date, the GOM has used the following insecticides in its locust control program, beginning with the 1987 campaign: malathion ULV, carbaryl 20 percent ULV, fenitrothion ULV, and DDVP (dichlorvos). Of the total amount of malathion and carbaryl used or to be used by Morocco during both the 1987 and present campaigns, AID has provided 140,000 l of malathion ULV and 183,000 l of carbaryl 20 percent ULV to the GOM under AID emergency procurement procedures. The fenitrothion and DDVP used by the GOM are obtained from other sources.

Fenitrothion has not and will not be provided to Morocco by AID, in part due to the fact that it is manufactured outside of the U.S., thus not meeting standard source and origin requirements for AID project assistance. Given that fenitrothion makes up a significant portion of the insecticide routinely being used by the GOM for locust control, it is likely that use of fenitrothion by the GOM will be "co-mingled" with other AID-funded services and commodities under the proposed project, e.g., aerial spray services, two-way radios, protective clothing and equipment, etc. As noted above, the preliminary conclusions of the L/G PEA (TAMS/CICP, 1988) recommend against terrestrial applications of fenitrothion due to problems with bird toxicity. This is an issue which will receive close technical scrutiny during review of the draft PEA, due in part to the findings of the Mali and Sudan field trials, which did not indicate significantly higher environmental risks associated with judicious use of fenitrothion in locust control applications. In view of these management and technical considerations, this EA provisionally approves AID assistance to the GOM in the aerial application of fenitrothion, subject to resolution of the technical issues associated with fenitrothion's environmental impact. Mitigative actions to be employed in this regard are described in Section 7.0.

DDVP is an organophosphate fumigant, which, while effective against locusts as a contact poison, has limited overall utility and is not cost-effective for large scale locust control efforts due to its extreme volatility, which means that application leaves virtually no residue. Due to this limitation, and in consideration of the occupational risks to pesticide handlers associated with reformulation of technical DDVP (which is acutely toxic) to the 4 percent (by weight) solution used for aerial treatment, use of this material is not recommended for locust control. In addition, on February 29, 1988 U.S. EPA published an "Initiation of Special Review" action for DDVP based on EPA's determination that exposure to DDVP from its registered uses (in the U.S.) may pose an adverse oncogenic risk and inadequate margins of safety for cholinesterase inhibition and liver effects to exposed individuals. The GOM has indicated that it has exhausted its stocks of DDVP and plans no further procurement of this material for use in locust control operations. In any event, none of the AID-funded aerial spray equipment to be provided under the proposed project will be employed in application of DDVP. In addition to human health concerns, there is a technical restriction to the use of AID-funded equipment in applying DDVP, since these spray systems will be designed for ULV application of carbaryl and malathion, and are thus not

calibrated for application of DDVP at the higher volumetric rate required for the 4 percent spray formulation.

The L/G PEA (TAMS/CICP, 1988), also analyzed the use of insecticides from the chlorinated hydrocarbon group, dieldrin and lindane in particular, and recommended against their use under any circumstances. Due to the high persistence of these chemicals in the environment and the risks associated with their demonstrated bio-accumulation in the adipose tissues of many animals, including humans, most uses of the chlorinated hydrocarbon pesticides have been cancelled in most industrial countries. In the current L/G campaign in Africa and the Near East AID has stipulated as a matter of policy that it will not participate in, or otherwise provide assistance to, any locust control program in which chlorinated hydrocarbons such as dieldrin, aldrin, benzene hexachloride (BHC) or lindane (gamma isomer of BHC) are being used, whatever their source. Although it received an unsolicited donation of dieldrin in 1987, the Government of Morocco has stated and repeatedly confirmed (including at several international locust control fora) its policy of non-use of dieldrin for locust control under any circumstances.

In summary, the insecticides which are eligible for procurement or use in Morocco (in the case of fenitrothion, use only) with AID assistance are those listed in Table 5-1, with the exception of diazinon, pending its registration review in the U.S. Based on cost, availability, past practice, and efficacy, however, the Morocco locust campaign will employ three materials more or less exclusively: malathion, carbaryl, and fenitrothion. Eligibility of AID assistance for any of the chemicals in Table 5-1 is subject to change based on the outcome of additional planned field tests and finalization of the L/G programmatic environmental assessment.

## 5.2 INTEGRATED PEST MANAGEMENT AND LOCUST CONTROL IN MOROCCO

Integrated pest management (IPM) consists of employing a coordinated mixture of control techniques, including chemical, biological, and cultural methods, in a scientifically based program which makes maximum use of monitoring and surveillance in order to control pest populations effectively at the earliest possible stage with the least intrusive interventions. This option is analyzed in detail in the L/G PEA (TAMS/CICP, 1988). In fact, IPM in the case of locust control would consist of some mixture of the candidate control methods which were evaluated in the alternatives analysis component of the PEA. At the present time and for the foreseeable future, Morocco's locust infestation will be at the outbreak stage, and as stated in Section 4.3, chemical control is the only effective means of dealing with the locust problem at this level. In this context, an IPM approach consists of "the judicious use of chemicals with a willingness to utilize other control methods should they become available. In terms of field operations it amounts to good, careful chemical control." (TAMS/CICP, 1988).

### 5.3 APPLICATION METHODS AND EQUIPMENT

The various insecticide application technologies commonly used in locust outbreak control are described in detail in the L/G PEA (TAMS/CICP, 1988). The Morocco locust control program includes a mixture of modern treatment techniques, ranging from individual hand-pump sprayers to gasoline-powered backpack or vehicle-mounted mist blowers to ultra-low volume aerial application from rotary and fixed wing platforms. The method applied in each particular instance depends on an array of site specific factors. The criteria employed for selection of application techniques form an important element of the overall control program strategy. Proposed AID assistance would include a package of commodities, equipment and technical assistance, including retrofitting of ten GOM helicopters with aerial ULV spray systems and provision of the services of an aerial spray/pesticide application specialist. In addition to assisting the GOM in technical interactions with the helicopter spray equipment vendor, the specialist would advise on maintenance, repair, and calibration of the rest of the GOM's inventory of aerial and ground application equipment. Guidance concerning specific application methods and strategies would also be supplied by the entomologist/environmental monitoring specialist (see Appendix B).

### 5.4 ACUTE AND LONG-TERM ENVIRONMENTAL AND TOXICOLOGICAL HAZARDS

A detailed analysis of the acute and chronic risks to humans associated with both public and occupational exposure to the insecticides selected for AID-funded locust control is presented in the L/G PEA (TAMS/CICP, 1988), and is applicable to the situation in Morocco. The three insecticides being used against locusts in Morocco (malathion, carbaryl, and fenitrothion) are moderately toxic to humans. The group at highest risk are the insecticide handlers (mixers, loaders, spraymen, etc.). All insecticides except for carbaryl provided with AID assistance in Morocco will be supplied and used in ready-to-use ULV formulations requiring no dilution before application. Field visits by the AID project design team to locust control pesticide storage and transfer centers and ongoing control operation sites revealed a reasonable level of basic occupational safety precautions to be in place, although there is room for improvement (see Section 5.9). Regarding risk to the general public, control operations for the most part are being conducted in remote, non-crop areas or rangeland, where public exposure will be at a minimum (see Section 5.7).

One aspect of the Moroccan locust control program which has both safety and AID policy implications is the disposal of empty insecticide drums. To date AID-funded insecticides provided to the Morocco locust control effort have alone resulted in the importation into Morocco of 1,179 (55 gal) drums containing either malathion (791 drums) or carbaryl (388 drums) and 880 (30 gal) drums containing carbaryl. As detailed in the L/G PEA (TAMS/CICP, 1988) empty pesticide drums, if improperly managed and disposed of, represent a significant environmental and safety hazard due to the presence of left over material (approximately 300 ml for a 55 gal drum) remaining in the "empty" container. All countries which receive donations of locust control pesticides consider the drums valuable commodities due to their potential for re-use,

both within and outside of the control effort. In theory, safe and environmentally sound re-use is possible if the drums are decontaminated, reconditioned, and re-labeled according to strict protocols, a fairly complex process requiring specialized facilities which are not available in most developing countries. Moreover, even if adequate facilities for reconditioning are available, collection and transportation of empty drums to a central location for decontamination and reconditioning is a serious logistical obstacle in the context of an ongoing emergency control operation. In view of these facts, AID has determined that, as a matter of Agency policy, any and all empty containers resulting from provision and use of AID-funded locust control insecticides will be destroyed or otherwise rendered useless, followed by disposal in an appropriate, environmentally sound manner. Compliance with this policy in Morocco is discussed in Section 7.3.

## 5.5 EFFICACY OF SELECTED INSECTICIDES FOR LOCUST CONTROL

The efficacy of the eight chemicals selected for AID-funded locust control is treated in the L/G PEA (TAMS/CICP, 1988) and is the subject of the ongoing AID locust control insecticide field testing project (Dynamac, 1988). The efficacy of malathion and carbaryl against locusts and grasshoppers has been demonstrated in the U.S. and elsewhere.

## 5.6 EFFECT OF SELECTED INSECTICIDES ON NON-TARGET ORGANISMS AND THE NATURAL ENVIRONMENT

The L/G PEA (TAMS/CICP, 1988) provides an in-depth review of existing information on the environmental impacts of the chemicals selected for locust control in Morocco. And, as has been stated previously (Section 5.1.1), one of the principal objectives of AID's ongoing field testing program (Dynamac, 1988) is to gather data on the environmental impacts of the selected L/G control insecticides under prevailing environmental conditions in Africa. This Morocco EA recommends the incorporation of routine pre- and post-treatment biological monitoring in Morocco as a component of each locust control campaign (Section 7.1.1) in order to document any adverse impacts and allow for necessary mitigative action.

An important area of concern is the possible interaction of locust control insecticides with public health (vector control) insecticide application programs. Problems can develop when the application of insecticides against agricultural pests results in increased resistance among disease vectors, thus decreasing the effectiveness of the vector control program. For example, applying fenitrothion to an area in which mosquitos (malaria vector) are being treated with malathion could cause irreversible resistance to malathion, as a result of the cross-resistance effect between fenitrothion and malathion in the mosquito. Consultations with the Ministry of Public Health indicated that this should not be a concern in the locust control program, since no insecticide-based vector control programs are being carried out in the arid regions subject to locust infestation. The relatively limited amount of insecticide application for malaria control carried out by the GOM occurs in the eastern coastal plains, out of the locust areas, and employs non-organophosphate insecticides.

## 5.7 CONDITIONS UNDER WHICH INSECTICIDES ARE TO BE USED

A general description of Morocco's natural and human environment was provided in Section 4.4. The current and projected locust infestations in Morocco are principally in a band which begins on the far south Atlantic coast between Dakhla and Sidi-Ifni, extending north and east following the Oued Draa along the southern foot of the Anti-Atlas Mountains through the area between Ouarzazate and Zagora, and continuing in a northeasterly arc along the southeastern foot of the High Atlas Mountains through Bouarfa to Oujda on the Mediterranean Coast. This area may be generally categorized as arid to semi-arid steppe with annual vegetation occurring for approximately six weeks during the winter rains. Livestock grazing (principally sheep, goats, and camels) occurs during those times when forage is available. Production of cereals and fruit trees center around a number of irrigated perimeters located in the region as well as fertile valleys in the central portion of the Anti-Atlas mountains.

Assuming that insecticide application for locust control could occur anywhere within the region described above, it is important to identify any environmentally sensitive areas within the region which would be at greatest risk from application of locust control insecticides, and which should therefore receive special consideration in the process leading to a decision to perform treatment, and, should treatment be elected, mitigative action. Given the prevailing arid conditions of the locust infestation region, environmentally sensitive areas within that region are centered around surface water features. These are discussed below, moving from south to north. Nature reserves and other protected areas within the locust control areas are described in Section 4.4.3.

The only area along the Atlantic coast likely to undergo aerial treatment with donor (including AID) assistance is the Plage Blanche, which lies between Sidi-Ifni and Tan-Tan. Plage Blanche consists of a beach backed by bare sand dunes 200 - 300 m wide. There are no salt water lagoons or marshland, but rainwater and moisture collects in a 400 - 500 m wide depression behind the dune system, resulting in annual vegetation. Behind the vegetated strip is a 200 - 300 m high rock escarpment, which is the edge of a dry coastal plain devoid of vegetation. Locust breeding has occurred in the green area behind the dunes. Aerial reconnaissance of Plage Blanche in late March 1988 revealed swarms of locusts in the vegetated area, and heavy concentrations of shore birds on the beach.

The Oued Draa is an intermittent stream system which extends from its source in the High Atlas mountains north of Ouarzazate southeast to Zagora, and then to the southwest along the southern boundary of the Anti-Atlas mountains to Cap Draa on the Atlantic coast. There is a large irrigation impoundment at Ouarzazate, and the stretch between Ouarzazate and Zagora has a number of smaller impoundments and oases. Locust breeding has occurred in a number of vegetated areas within this region, as well as in waddis extending north from the Oued Draa into the Anti-Atlas mountains. Along its southwesterly course from Zagora to the Atlantic, the Oued Draa exhibits a number of perennial

surface water features in the form of oases and small impoundments. Locust breeding has occurred in many of these areas as well.

There is a large irrigation impoundment north of Er-rachidia, and locust control operations are being mounted to the south in the grasslands and cultivated areas which surround the irrigated perimeter. Although locusts have been reported as far north as Oujda on the Mediterranean coast, this area is not well-suited for locust breeding due to the relatively high salinity of the soils. It is therefore unlikely that large scale locust control will be undertaken in the northern coastal area.

#### 5.8 AVAILABILITY AND EFFECTIVENESS OF OTHER INSECTICIDES AND/OR NON-CHEMICAL CONTROL MEASURES

As discussed in Sections 4.3, 5.1, and 5.2, chemical control by means of the specified insecticides is presently the only viable alternative for addressing Morocco's locust problem. AID will stay abreast of new developments in the field of biological and other non-chemical control methods, and seek to incorporate them into its project assistance, in Morocco and elsewhere, as feasible.

#### 5.9 ABILITY OF THE GOVERNMENT OF MOROCCO TO REGULATE OR CONTROL THE DISTRIBUTION, STORAGE, USE, AND DISPOSAL OF PESTICIDES

Morocco imports 5,000 metric tons (5 million kg) of pesticides (as formulated product) annually. The breakdown of this material, which is composed primarily of crop protection chemicals, is as follows:

Insecticides	-	52 percent
Fungicides	-	25 percent
Herbicides	-	10 percent
Others	-	12 percent

No active ingredients are manufactured in Morocco, but there are four private sector pesticide formulators.

As discussed in Section 2.3, the GOM's pesticide regulatory system is complex and outdated. Responsibility for pesticide registration and regulatory development and enforcement lies in the GOM Plant Protection Service's Bureau of Pesticides and Registration. This office, which is staffed by qualified agricultural chemists, is in the process of developing streamlined and updated regulations for pesticide registration, labeling, sale, distribution, storage, use, and disposal, as well as residue tolerances for food crops. Technical effort on this regulatory development process has been underway for three years, and it is expected that at least two more years will be required to promulgate the new rulemaking package. In some respects, the objective of this effort to modernize Morocco's pesticide regulations is to bring the rules

into conformance with actual current practice. For example, because of its significant exports of fruits and vegetables to European countries, Morocco must routinely comply with the pesticide residue limits imposed by the regulations of its trading partners for agriculture products.

In addition to its regulatory development activities, the Bureau of Pesticides and Registration conducts scientific reviews, including field testing, to screen all new pesticides proposed for importation into Morocco for efficacy and toxicological risk. Each new product which passes initial screening receives a three year provisional registration during which time it undergoes follow-up field testing prior to full registration. The field testing is supervised by regional inspectors which report to the Registration Bureau in Rabat. The Bureau also issues technical directives and guidelines to the field concerning storage, handling, and disposal of pesticides, pesticide wastes, and empty containers. In the ongoing locust control program, the Bureau of Pesticides has been assigned responsibility for analysis of the effects of insecticide application on non-target flora and fauna (GOM, 1988).

Routine quality assurance checks on imported agricultural chemicals as well as pesticide residue analyses are performed at the Laboratoire Officiel d'Analyses et de Recherches Chimiques in Casa Blanca. This laboratory is well-equipped with standard pesticide analytical apparatus and instrumentation, including gas-liquid chromatographs and high performance liquid chromatographs. Quality assurance tests of pesticides imported for locust control are regularly carried out at the Official Laboratory. The Pesticide Bureau, in conjunction with the Laboratory, is currently in the process of starting up a program to monitor for pesticide residues in environmental media as a result of the locust control effort.

In recognition of the special requirements of a large and complex operation such as the locust control program, the GOM has established a Locust Task Force to coordinate the activities of the various GOM ministries concerned with the program, and to provide centralized guidance and operational leadership to the campaign. The task force is headed by the General Commandant of the Gendarmerie Royale and includes representatives of the Ministries of Interior, Agriculture, Transport, National Defense, and Public Health. The task force operates out of a central command post in Rabat and a number of field operation posts which have been established and staffed to manage the campaign. Communication between the central and field posts is carried out by means of an efficient system of telephone, telex, radio, and computer links.

The Ministry of Public Health (MOPH) is playing a key role in the locust control program. The MOPH has been assigned responsibility for developing appropriate safety measures for the general public in treated areas to minimize insecticide exposure; for informing provincial medical authorities concerning medical interventions to be applied in the event of intoxication; and for coordinating the Locust Task Force's efforts concerning occupational health among the workers handling insecticides, including prevention, detection, and treatment of poisoning cases (GOM, 1988). The MOPH is in the

process of designing a program for worker exposure monitoring (see Section 7.1.3), and has already established a network of well-equipped field emergency medical units in the locust control operational area. The Plant Protection Service is providing protective clothing and equipment for workers involved in the locust control operation who are in high pesticide exposure job categories.

The Ministry of Interior is responsible for mounting a public information campaign in the areas under treatment for locusts concerning necessary safety precautions to be taken by affected inhabitants, and for enforcing prohibitions on consumption of treated locusts. Interior is also charged with overseeing compliance with guidelines adopted by the locust task force which prohibit use of pastureland for at least one month following treatment with insecticides.

In general, GOM use of insecticides in the locust control program reflects a sound basic knowledge and understanding of safety, health, and environmental considerations. Shortcomings in facilities and equipment exist, however. For example, none of the pesticide staging areas visited had adequate change room, shower, and laundry facilities for workers handling pesticides. Command and control of aerial spray operations is hampered by lack of ground to air radios and field marking equipment. More important, however, is the challenge to translate knowledge into action, especially in the context of an operation which is being mounted on an emergency basis. Many illustrations of this problem could be cited, among them:

- (1) Although Plant Protection Service guidelines prohibit re-use of empty pesticide drums, it is being done routinely in the field. During one site visit, workers were observed loading re-formulated fenitrothion (for transport to the field to be used in back pack sprayers) into empty malathion ULV drums which were bearing the original product label and had no doubt been neither decontaminated nor reconditioned (and certainly not re-labeled) prior to this re-use.
- (2) The condition of insecticide drums once they reach field operation posts indicates that they receive very rough treatment in transit. In one instance, a drum that had ruptured completely along one seam was observed, apparently the result of rolling the drum off the back of a truck directly onto the tarmac without using either a ramp or cushioning material. A fork lift was available at that particular location.

All of this points up the need for technical assistance and training, which is one of the key elements of the recommended environmental mitigations (see Sections 5.10 and 7.1).

## 5.10 PROVISIONS FOR TRAINING LOCUST CONTROL INSECTICIDE USERS

Training under the proposed project will be accomplished at several levels and in various contexts. All of the proposed specialists to be provided under the technical assistance component will work very closely with

GOM counterparts in the course of carrying out their responsibilities under the project, thus imparting knowledge and skills in the form of on-the-job professional development. In addition, each specialist will be expected to stage an appropriate number of short-term in-service training activities for field personnel. The specialists proposed under the project are as follows (see Section 7.1 and Appendix B for detailed scopes of work):

- Entomologist/Environmental Monitoring Specialist
- Pesticide Management and Health/Safety Specialist
- Cholinesterase Monitoring Test Kit Training Consultant
- Aerial Spray Equipment Specialist (not included in Appendix B)

#### 5.11 PROVISIONS FOR MONITORING THE USE AND EFFICACY OF THE SELECTED INSECTICIDES

The GOM Plant Protection Service keeps detailed records of the quantities and types of chemicals applied and the extent (in ha) and locations of the areas treated. The PPS does not, however, have an institutionalized procedure for monitoring the efficacy of locust control insecticides used in the emergency program. Since it may take up to 48 hours for insecticides such as malathion, carbaryl, and fenitrothion to result in significant mortality, control workers normally have moved on to other areas before results of treatment are observable. Any assessments of efficacy which are made are approximations only, and are not based on quantitative sampling techniques. Efficacy studies are a key component of AID's field testing program (Dynamac, 1988), the findings of which will be applied to the Moroccan program as appropriate.

## 6.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

A detailed technical analysis of the full range of potential environmental impacts of insecticide-based locust control is presented in the L/G PEA (TAMS/CICP, 1988) and will not be repeated here. The following sections highlight impacts in the context of the situation in Morocco.

### 6.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Aerial and ground application of locust control insecticides will have significant effects on some non-target organisms, including locust predators and parasites; pollinators and other beneficial insects; birds (especially in the case of fenitrothion); and possibly some higher animals. It is likely that insecticides will be applied near some or all of the protected and/or sensitive ecological areas identified and described in Sections 4.4.3 and 5.7 of this EA. In such cases, judicious, and carefully planned and executed application is a must (see section 7.2). Biological monitoring of impacts on non-target organisms is a critical component of the proposed project, and the results of these studies must feed back into overall management of the locust control program. Similarly, any relevant findings of AID's ongoing insecticide field testing program (Dynamac, 1988) should be taken into consideration during project implementation.

### 6.2 THE RELATIONSHIP BETWEEN SHORT-TERM IMPACTS AND LONG-TERM PRODUCTIVITY

The L/G PEA (TAMS/CICP, 1988) analyzes the risks and benefits, both short and long-term, associated with locust control programs. Major benefits would accrue as a result of the program if a locust plague is averted. However, since plague prevention is dependent on regional actions as opposed to, for example, Morocco's program alone, it is difficult to consider Morocco's program in isolation from a risk-benefit standpoint. The equation is also complicated by the costs and short-term effects of unpredictable events such as accidents (chemical spills, fires, spray plane crashes, etc.). The ultimate conclusion depends of the analyst's degree of confidence in the supposition that emergency locust control operations are an element in the effective prevention or containment of long-term locust plagues.

### 6.3 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

The proposed project would result in the irretrievable consumption of petro-chemicals in the form of internal combustion engine fuel (by aircraft and ground vehicles) and insecticides. Relatively small amounts of other non-renewable resources would also be expended by the project. In the unlikely event that insecticide application were to permanently alter some aspect of the affected ecosystem, this would represent an irreversible change. Given the low persistence of all of the selected locust control insecticides in the natural environment, this is not expected to occur.

## 7.0 MITIGATION OF ENVIRONMENTAL IMPACTS

There is a vast literature on the prevention and mitigation of environmental impacts of the handling and use of pesticides in general and locust control insecticides in particular, much of which has been reviewed and analyzed in the context of locust control in Africa as presented in the L/G PEA (TAMS/CICP, 1988). In addition, AID's current L/G insecticide field testing program (Dynamac, 1988) is yielding directly relevant information on impacts of specific insecticides and how to minimize them. This section provides guidance on specific environmental and safety mitigative actions which are considered necessary for the proposed Morocco locust control project in particular.

### 7.1 ENVIRONMENTAL/HEALTH/SAFETY TECHNICAL ASSISTANCE, COMMODITIES, AND EQUIPMENT

The design of the technical assistance component of the proposed project allows for identification and implementation of required mitigative actions based on the results of observations and data gathering made in the course of carrying out the prescribed technical assistance. In that sense, the technical assistance itself is both the starting point and vehicle for most of the mitigations which will occur under the proposed project. In addition, the provision of certain specialized equipment items is recommended as a part of the proposed project's environmental mitigation package. Recommended technical assistance and commodities are described below (refer to Appendix B for complete scopes of work and equipment specifications).

#### 7.1.1 Entomologist/Environmental Monitoring Specialist

This individual, who would be contracted to serve in Morocco for a period of two months during each locust campaign for the duration of the project, would provide broad-ranging scientific guidance to USAID/Morocco and the Government of Morocco (GOM) in conducting the national locust control program. The Entomologist/Ecologist would be responsible for providing long-range technical advice to the Mission and the GOM regarding locust control strategy, management options, and policy, and for collecting and analyzing data on the environmental impact of small spray plane and/or ground application of ULV malathion, fenitrothion, and carbaryl in the Morocco Locust control effort. An important function of the Entomologist/Ecologist will be to provide on-site field training to GOM counterparts in locust biology; identification; aircraft calibration and ground guidance procedures; techniques for field evaluation of insecticide application patterns; and assessment of biological impacts of insecticide application for locust control.

The Entomologist/Ecologist would serve as the principal scientific advisor to USAID's locust control project and would have direct responsibility for technical management of the project, including, among other things, pesticide usage strategy, locust outbreak forecasting, counterpart training, and

situation assessment. The Entomologist/Ecologist would also be responsible for designing and implementing a program to conduct appropriate pre- and post-pesticide application environmental monitoring of selected areas, chosen in consultation with Mission and GOM technical personnel. Biological effects of the locust control insecticides on the environment would be assessed by monitoring changes in populations of species selected on the basis of economic importance (beneficial insects - locust predators or parasites, pollinators); known sensitivity to the chemicals being used, and/or known vulnerability due to position in the particular ecosystem being studied. Biological monitoring would also include assessment of changes in species diversity in treated areas and study of physiological and behavioral parameters. A critical responsibility of the Entomologist/Ecologist would be coordination with GOM counterparts to identify those areas within the locust control region which are critical habitats for endangered wildlife species, and implementation of an appropriate strategy for minimizing impacts on these species as a result of the locust control effort.

The Entomologist/Ecologist will be required to prepare a detailed report which will summarize all data, findings, conclusions and recommendations stemming from the field effort, including a separate section which fully describes all recommended environmental mitigation actions associated with the Morocco Locust Control effort, including implementation procedures, duration, training requirements, estimated capital and recurrent costs, and agencies responsible for execution. This section would focus on recommended programmatic interventions on the part of USAID, especially those with management implications, i.e., requiring significant changes in project direction or scope. All recommendations would be required to be cost effective and implementable under Moroccan conditions.

#### 7.1.2 Pesticide Management and Health/Safety Specialist

This services of this individual, who would be contracted to serve in Morocco for a period of one month during each locust campaign for the duration of the project, would assist the GOM in safeguarding the health and safety of workers involved in the chemical control aspects of the locust effort as well as the general public; lessen the possibility of accidents involving insecticides; and enhance the GOM Plant Protection Service's emergency response capability. The specialist would have primary responsibility for advising the GOM Plant Protection Service on matters involving pesticide management, safety, and health within the overall locust control program, and would advise the GOM Ministry of Public Health concerning development and implementation of programs to minimize health risks to the general public as a result of the locust control effort. A critical responsibility of the Health and Safety Specialist would be to conduct an in-service training program for GOM Plant Protection employees on the safe handling and management of pesticides in the locust control effort. Another key responsibility of this specialist would include an analysis of the Crop Protection Service's locust control pesticide management system by means of extensive site visits to observe the entire pesticide handling network, including receiving (port/airport); temporary storage; transport; warehousing; re-formulation;

distribution; use in active locust control areas; and temporary storage/ultimate disposal of wastes and empty containers, and recommendation of improved procedures as necessary.

### 7.1.3 Cholinesterase Monitoring Test Kits

Under this procurement, the Ministry of Public Health (MOPH) would be provided with 15 field kits and a supply of associated expendable items for routine monitoring of whole-blood cholinesterase levels in workers exposed to pesticides in the course of the GOM locust control program. The kits are designed for use under harsh field conditions by technicians with minimal training. The use of this kit will allow the MOPH to screen workers for cumulative intoxication with cholinesterase-inhibiting pesticides (organo-phosphates and carbamates, including malathion, fenitrothion, and carbaryl) and thus prevent potential cases of chronic pesticide poisoning.

A consultant would be contracted to conduct a training program in the use of the test kit for Government of Morocco Ministry of Public Health management and technicians assigned to the current locust control campaign. The Consultant would also be responsible for advising the MOPH on the development and implementation of a national program for the protection of workers at risk due to high body burdens of cholinesterase-inhibiting pesticides based on data collected using the test kit. Finally, the Consultant would advise the MOPH on administrative and management techniques for timely and effective use of worker monitoring results by means of appropriate methods for data management and handling.

### 7.1.4 Clothing and Personal Protective Equipment

Under this procurement the Government of Morocco Plant Protection Service would be provided with a supply of appropriate protective clothing and equipment for use by workers exposed to pesticides in the course of the locust control effort. This equipment is intended for workers at risk due to high and/or long-term exposures, i.e., formulators, aircraft loading and service crews, mist blower operators, etc., and would include industrial grade head and eye protection; organic vapor respirators; and chemical resistant coveralls, boots, and gloves.

## 7.2 INSECTICIDE APPLICATION IN ECOLOGICALLY SENSITIVE AREAS

In general, control of locusts at the hopper band stage by means of carbaryl barrier application is preferred over blanket spraying of settled or flying swarms, since barrier spraying requires smaller treated areas, and thus lower quantities of insecticide application. Also, alternating untreated strips with the treated barriers allows for more rapid regeneration of non-target organisms in the treated areas. Following are specific guidelines for locust operations in ecologically sensitive areas:

1. Under no circumstances should aerial application of insecticides occur in legally protected areas (see Section 4.4.3). If hopper bands are present in the protected area, treatment should be deferred until the hoppers move out of the area. Control can be achieved in that case by placing barrier strips of carbaryl around the perimeter of the protected area (with at least a 100 m buffer zone). If compelling circumstances make treatment of hopper bands within the protected area an absolute necessity, this should be done by means of selective spraying of hoppers with malathion using ground equipment only. If swarms are present in the protected area, treatment should be deferred until they move out of the area.

2. Other ecologically sensitive areas not under legal protection (see Section 5.7) should, as much as possible, be accorded the same treatment as the protected areas. Otherwise, minimum guidelines for non-protected sensitive areas are as follows:

a. During field surveys for locusts in sensitive areas (which, in the arid regions of Morocco, translates into areas near surface water features), survey personnel should note the presence of any sensitive receptors such as active water supplies; settlements; cultivated fields and/or orchards; livestock herds; and non-target organisms, including birds, pollinating insects, and other wildlife. All such information should be gathered and considered in deciding whether or not to treat, and, if treatment is elected, the timing and mode of treatment.

b. If any endangered species are suspected to be present, treatment should be deferred pending consultation with appropriate officials or specialists.

c. After full consideration of all of the above factors, if treatment in a sensitive area is elected, carbaryl should be used exclusively, due to its lower impact (compared to malathion and fenitrothion) on both terrestrial and aquatic non-target organisms. Under no circumstances should fenitrothion be used where birds are present. If aerial spraying is performed, helicopters should be used in order to accurately pinpoint the target and minimize overspray and drift.

3. Post-application biological and insecticide residue monitoring should be performed at selected sites during each locust campaign to identify any adverse environmental impacts of spray operations. The results of the monitoring should be factored into planning of subsequent operations in the affected areas. See proposed scope of work for the "Entomologist/Environmental Monitoring Specialist" (Section 7.7.1 and Appendix B).

### 7.3 MANAGEMENT OF LOCUST CONTROL INSECTICIDE DRUMS

As discussed in Sections 5.4 and 5.9, improper management of insecticide drums (whether full or empty) can result in severe safety and health hazards and environmental impacts. Due to the scale and complexity of

Morocco's locust control program, large numbers of drums of liquid insecticide are involved. Proper management of these drums throughout the extensive distribution network, from acceptance through disposal, represents a significant logistical and management challenge. The following guidelines are based on random observations made in the course of field visits during preparation of this EA, and on AID policy. Additional and more comprehensive guidance will be generated by the Pesticide Management and Health/Safety Specialist to be provided under the proposed project (Section 7.1.2).

1. Large numbers of unattended drums (both "empty" and containing material) were observed out in the open on the flight line at a number of airstrips in remote rural areas in which access by the public is not restricted. This is an obvious safety hazard. All pesticides, and all pesticide containers which have not been both decontaminated and rendered useless, should be under 24 hour guard, even if they are in a "secure" area and/or in an enclosure under lock and key.
2. As discussed in Section 5.9, insecticide drums are subject to very rough handling in transit from the point of reception to point of use. Due to the danger of spills and accidents from ruptured drums, and the near impossibility of uniform enforcement of proper drum handling procedures, it is recommended that 30 gallon (as opposed to 55 gallon) drums of the heaviest possible gage steel be specified in all insecticide procurements.
3. As discussed in Section 5.4, it is AID policy that any and all empty containers resulting from provision and use of AID-funded locust control insecticides will be destroyed or otherwise rendered useless, followed by disposal in an appropriate, environmentally sound manner. Of the 2,059 drums of insecticide contributed by AID to Morocco's locust control program since November 1987, it appears likely (based on field observations and interviews of knowledgeable individuals) that none have been properly disposed of as yet. This is due in part to the utility of the empty drums for such purposes as transporting reformulated insecticides for use in ground spray operations, and also due to the difficulty, in the midst of an emergency operation, of applying resources (human and fiscal) to what is perceived to be a low priority activity. The following management plan for disposal of AID-funded insecticide drums represents a reasonable compromise between what would be ultimately desirable from an environmental protection standpoint, and what is achievable in the context of the proposed project. The plan presupposes the retroactive collection and disposal of empty AID-funded drums already in-country using the methods outlined below. It is important that the plan be instituted immediately and consistently implemented in order to avoid another backlog of drums awaiting disposal.
  - a. This plan is decentralized, on the assumption that disposal of empty drums at a different site from the one in which they were opened and used adds a layer of logistical complexity and requires an extra degree of management oversight. If consolidation of drums from two or more sites for disposal is desirable and appears to be technically feasible in particular instances, it should be considered on a case-by-case basis.

b. Basic facilities, equipment, and supplies required at each site in which disposal is to take place are: a fenced or other appropriate secure enclosure near the area in which planes are loaded with insecticide and under 24 hour guard, reserved exclusively to serve as a holding area for empty USG-supplied drums awaiting disposal; a simple rack located near the enclosure for draining empty drums and collecting the drained material (by means of a trough or other appropriate device) for recycling; tools for cutting the tops out of the drums and puncturing the sides and bottom; and fuel for flaming out the drums.

c. The disposal activity itself will be carried out during the "down time" between active locust campaigns. During ongoing locust control operations, drums will simply be transferred to the holding enclosure immediately upon being emptied, and will be temporarily stored there until a lull in operations allows attention to the disposal process.

d. For each drum, the recommended disposal procedure is: (1) Remove the drum from the holding enclosure and cut the top out; (2) Invert the drum on the draining rack, and allow it to drain for at least 12 hours; (3) Transport the drum to the disposal site, which should be well removed from human habitation and preferably in an area of clay soils and/or a low water table; (4) Douse the drum with fuel and flame off residual chemical; and (4) Puncture the sides and bottom of the drum with enough holes to make it completely unusable. At this point, if a bulldozer or other suitable equipment is available at the disposal site, the drum should be crushed and buried in a shallow trench. Otherwise, it should be left on the surface to weather.

e. A system should be established whereby the GOM would generate reports on a monthly basis (say), detailing the status of the USG drums under its control by individual location, indicating at a minimum: number of drums received since last report and total number of USG drums on hand; number of full drums awaiting use; number of empty drums being held for disposal; number of drums disposed of since last report and means of disposal; and a description of problems encountered and remedial measures taken.

## 8.0 LIST OF PREPARERS

1. M. Glenn Rutanen-Whaley  
B.S. Chemistry; M.S.P.H. Environmental Sciences and Engineering  
Environment and Natural Resources Officer  
U.S. Agency for International Development  
Bureau for Asia and the Near East  
Washington, D.C.
2. George E. Cavin  
B.S. Biological Sciences  
Registered Professional Entomologist  
Consultant, Consortium for International Crop Protection  
College Park, MD  
Formerly Regional Director for Latin America and the Caribbean, U.S.  
Department of Agriculture, Animal and Plant Health Inspection Service
3. Richard W. Dyer  
Consulting Aerial Pesticide Application Specialist  
Consultant, Consortium for International Crop Protection  
College Park, MD  
Formerly Supervisory Agricultural Pilot and Certified Regulatory  
Pesticide Applicator, U.S. Department of Agriculture, Animal and Plant  
Health Inspection Service
4. John J. Drea  
B.S. Biology; B.S. Entomology; Ph.D. Entomology (Biological Control)  
Research Entomologist  
U.S. Department of Agriculture  
Agricultural Research Service  
Beltsville, MD
5. Robert G. Hellyer  
B.S. Agronomy; M.S. Entomology  
Agricultural Development Officer  
USAID/Morocco  
Rabat, Morocco
6. Ronald S. Stryker  
B.S. Agronomy; M.S. Soil Science; Ph.D. Plant Physiology  
Agricultural Development Officer and Mission Environmental Officer  
USAID/Morocco  
Rabat, Morocco

## 9.0 REFERENCES

- AID. 1980. Agency for International Development, Environmental Procedures. U.S. Code of Federal Regulations, Title 22, Part 216.
- AID. 1987. Project Paper, Africa Regional Emergency Locust/Grasshopper Assistance Project (698-0517).
- ALIC. 1980. Draft Environmental Profile (Phase I) of the Kingdom of Morocco. Arid Lands Information Center, Office of Arid Lands Studies, University of Arizona, Tucson, Arizona. NPS Contract No. CX-0001-0-0003, U.S. Man and the Biosphere Secretariat. February 1980.
- Drucker, G.R.F. 1987. Directory of the Protected Areas of North Africa (Draft). Protected Areas Data Unit, IUCN Conservation Monitoring Unit, Cambridge, U.K. April 1987.
- Duvall, L. 1988. The Status of Biological Resources in Morocco (Draft). Forestry Support Program. Agency for International Development, Bureau for Science and Technology. January 1988.
- Dynamac, 1988. Results of the Mali Pesticide Testing Trials Against the Senegalese Grasshopper (Draft). AID African Grasshopper/Locust Pesticide Testing Project. Dynamac International, Inc. January 1988.
- GOM. 1988. Royaume du Maroc Organisation de la Lutte Antiacridienne. Briefing Book. Government of Morocco. January 1988.
- Pinto, L.J., Mann, J.B., and Botrell, D.G. 1988. Environmental Assessment of Aerial Application of Fenitrothion ULV for Locust Control in the Sudan Multi-Donor Locust/Grasshopper Control Program. Consortium for International Crop Protection/FAO. February 1988.
- TAMS/CICP. 1988. Programmatic Environmental Assessment for Locust and Grasshopper Control in Africa and Asia (Draft). TAMS, Inc., and the Consortium for International Crop Protection (CICP). April 1988.
- USAID/Morocco. 1986. Country Development Strategy Statement FY 1988, Annex C, The Agricultural Sector in Morocco: A Description. USAID/Morocco. February 1986.
- USDS. 1986. Morocco: Background Notes. U.S. Department of State, Bureau of Public Affairs. July 1986.

APPENDIX A  
PERSONS CONTACTED

APPENDIX A  
PERSONS CONTACTED

Government of Morocco

1. M. Lakhdar  
Plant Protection Service  
Ministry of Agriculture
2. M. Ben Halima  
Plant Protection Service  
Ministry of Agriculture
3. Ahmed El Harmouchi  
Bureau of Pesticides and Registration  
Plant Protection Service  
Ministry of Agriculture
4. Mohammed Akchati  
Bureau of Pesticides and Registration  
Plant Protection Service  
Ministry of Agriculture
5. Dr. Idrissi Larbi  
Chief, Toxicology  
National Institute of Hygiene
6. Dr. Faouad Mahjour  
Chief, Parasitic Diseases  
Division of Epidemiology  
Ministry of Public Health
7. M. Bennouna  
Environmental Health Service  
Ministry of Public Health

Other

1. Adel N. Cortas  
Resident Representative  
UN Food and Agriculture Organization, Morocco Country Office
2. A. Bouchanine  
Programme Officer  
UN Food and Agriculture Organization, Morocco Country Office
3. John A. Franklin  
Area Director, Africa  
Animal and Plant Health Inspection Service  
U.S. Department of Agriculture

APPENDIX B

RECOMMENDED TECHNICAL ASSISTANCE AND COMMODITIES  
FOR MITIGATION OF ENVIRONMENTAL AND HEALTH/SAFETY IMPACTS

	<u>Page</u>
SOW and Costs for Entomologist/Environmental Monitoring Specialist . .	B-2
SOW and Costs for Pesticide Management and Health/Safety Specialist. .	B-7
SOW and Costs for Cholinesterase Monitoring Test Kit Training Consultant . . . . .	B-11
Specifications and Costs for Protective Clothing and Equipment . . . .	B-14
Specifications and Costs for Cholinesterase Monitoring Test Kits and Accessories. . . . .	B-16

STATEMENT OF WORK AND ILLUSTRATIVE COSTS  
ENTOMOLOGIST/ENVIRONMENTAL MONITORING SPECIALIST

I. OBJECTIVE

The objective of this procurement is to contract a specialist to provide broad-ranging scientific guidance to USAID/Morocco and the Government of Morocco (GOM) in conducting the national locust control program. In addition to performing the specific tasks set forth below, the Contractor shall be responsible for providing long-range technical advice to the Mission and the GOM regarding locust control strategy, management options, and policy.

The objective of the environmental monitoring portion of the Contractor's scope of work is to provide information on environmental impact of small spray plane and/or ground application of ULV malathion, fenitrothion, and carbaryl in the Morocco Locust control effort. The biological effects of pesticides on the environment can be assessed by monitoring changes in populations of species selected on the basis of economic importance (beneficial insects - locust predators or parasites); known sensitivity to a pesticide, or known vulnerability due to position in the particular ecosystem. Biological monitoring can also be done by assessing changes in species diversity in ecosystems or by studying physiological and behavioral parameters.

II. QUALIFICATIONS AND EXPERIENCE

The Contractor shall be a qualified agricultural and/or integrated pest management entomologist, preferably with African locust or grasshopper control program experience, and with direct experience in conducting pre- and post-treatment environmental surveys for determination of the environmental impact of aerial insecticide applications for crop and rangeland protection. The Contractor shall have knowledge of, and be experienced in standard assessment procedures for biological monitoring associated with pest control efforts, and shall be capable of interpreting data and making programmatic recommendations based on such assessments. Developing country experience is highly desirable. French language capability at or above the FSI 3-3 level is required.

III. STATEMENT OF WORK

A. General

The Contractor's effort during each TDY shall be organized around two principal scopes which will run simultaneously and in parallel. Scope A will consist of activities associated with technical direction of the large scale control effort, while Scope B will entail environmental and biological monitoring of the pesticide application program. Activities will be field oriented, under harsh environmental conditions.

Under Scope A, the Contractor shall serve as the principal scientific advisor to USAID's locust control project and shall have direct responsibility for providing broad-ranging technical advice and direction to the project, including, among other things, pesticide usage strategy, locust outbreak forecasting, counterpart training, and situation assessment.

Under Scope B, the Contractor shall be responsible for planning and conducting appropriate pre- and post-pesticide application environmental monitoring of selected areas, chosen in consultation with Mission and GOM technical personnel. Pre- and post-monitoring of beneficial species, including parasites and predators as well as other species, shall be executed. The Contractor's duties shall include interpretation of all data collected during the surveys and development of appropriate programmatic recommendations.

#### B. Specific

For each locust control campaign during the life of the project in which such services are deemed necessary, the Contractor shall:

##### SCOPE A AND B:

1. Prior to departure to Morocco, develop technical protocols for pre- and post-treatment environmental monitoring of locust control areas. Consultations with appropriate USG and academic specialists in terrestrial and aquatic ecology, and pesticide application impact assessment shall be undertaken in the course of carrying out this task.

2. Perform a two-day official TDY in AID/Washington immediately before and after each Morocco TDY to receive/deliver briefings on the current locust situation and to confer on other project matters with Morocco Locust Control Project backstop personnel, including review of proposed environmental monitoring protocols.

3. Upon arrival in-country, prepare a detailed work plan and schedule for Mission review, setting forth the principal tasks under the scope of work, and how they will be implemented, including identification of all Mission and GOM support and/or coordination which will be required.

##### SCOPE A:

1. Oversee the field application of pesticides and advise on the types of pesticides and formulations most suitable for use; selection of application equipment; and specification of maintenance and repair services.

2. Maintain liaison with the GOM Crop Protection Service to advise on control strategies based on locust development, both within Morocco and throughout the global locust breeding areas.

3. Forecast possible locust invasions and invasion routes, and timing of needed control interventions.

4. Advise the Mission on additional support requirements that may be necessary to protect against significant crop damage and evaluate the extent of any crop damage that may occur.
5. Provide on-site field training to GOM locust control personnel as to locust biology; identification; aircraft calibration and ground guidance procedures; and techniques for field evaluation of insecticide application patterns.
6. Assist GOM locust control personnel in delineating protected nature reserves as well as non-protected but nonetheless ecologically sensitive areas within the locust treatment region; identify areas with the potential for harboring endangered species; and advise on appropriate, environmentally sound locust control strategies within these areas.
7. Prepare situation reports on a weekly basis for submission to USAID.
8. Summarize all data, findings, conclusions and recommendations resulting from the field effort in a report to be prepared and finalized prior to departure from Morocco. The report shall include a full description of the status of Morocco's locust problem; a forecast of trends in the locust situation; and recommended programmatic interventions on the part of USAID, especially those with project management implications, i.e., requiring significant changes in project direction or focus.

SCOPE B:

1. In consultation with Mission and GOM technical personnel, select an appropriate number of candidate test plots of manageable size and in reasonably accessible locations, taking into account the ongoing pesticide application program, representative ecological considerations, and logistical factors. Monitoring shall be undertaken in areas harboring larval forms undergoing ultra-low volume (ULV) aerial or ground treatment. Test plot size shall range from 0.5 to one hectare, and shall be replicated at least once with adequate numbers of untreated control plots. All areas selected for plot establishment should be typical of those in which desert locust control is normally undertaken in Morocco.
2. For each test plot, perform a detailed baseline pre-treatment count of animals beneficial to the agricultural ecosystem, i.e., locust predators/parasites and other arthropods affecting crop production, as well as other taxa including birds, small mammals, reptiles and amphibians (if applicable) using appropriate techniques, such as sweep netting, pitfall traps, visual transect counts, and ant surveys. Perform a similar assessment of each control plot.
3. Specify and record the formulation and application rate of the particular pesticide applied to each test plot.

4. For each test plot, perform a detailed post-treatment count of animals beneficial to the agricultural ecosystem, i.e., locust predators/parasites and other arthropods affecting crop production, as well as other taxa including birds, small mammals, reptiles and amphibians (if applicable) using appropriate assessment techniques, including carcass counts. Post-treatment counts should be repeated at suitable time intervals (e.g., one, seven, and 14 days following treatment) for each test plot.

5. Employing standard analytical methods, interpret the data collected in order to obtain accurate measures of the adverse effects of each pesticide used on animals beneficial to the agricultural ecosystem, i.e., locust predators/parasites and other arthropods affecting crop production.

6. Similarly, quantify direct mortality or other acute effects on the full range of fauna and flora in the test plot ecosystems.

7. Advise the GOM Plant Protection Service concerning insecticide residue monitoring in environmental media. Attempt to coordinate the GOM residue monitoring program with the post-spray environmental monitoring effort under this scope of work, in order to correlate residue data with observed non-target organism morbidity or mortality.

8. Advise Mission and GOM concerning any recommended actions stemming from the findings of the ecological studies.

9. Summarize all data, findings, conclusions and recommendations resulting from the environmental monitoring analyses in a report to be prepared and finalized prior to departure from Morocco. The report shall include a separate section which fully describes all recommended environmental mitigation actions associated with the Morocco locust Control effort, including implementation procedures, duration, training requirements, estimated capital and recurrent costs, and agencies responsible for execution. This section shall focus on recommended programmatic interventions on the part of USAID, especially those with management implications, i.e., requiring significant changes in project direction or scope. All recommendations shall, however, be cost effective and implementable under Moroccan conditions.

#### IV. LEVEL OF EFFORT

The estimated level of effort for the Contractor for each locust control campaign (assuming one TDY to Morocco per campaign), inclusive of travel time, is six days of consultations in the U.S. with ecological specialists, four days in AID/Washington and 60 work days in Morocco (six day work week).

V. ILLUSTRATIVE COSTS\*

<u>ITEM</u>	<u>AMOUNT</u>
Salary - 70 days @ \$260/day -----	18,200
Domestic U.S. travel - two RT's -----	1,500
International travel - one RT U.S./Morocco -----	2,500
In-country travel	
Air -----	1,500
Vehicle rental -----	5,000
Per diem	
U.S. - 10 days @ \$120 -----	1,200
Morocco - 60 days @ \$78/day -----	4,680
Miscellaneous	
FICA @ 7.5 percent salary -----	1,365
DBA @ \$2.57/100 salary -----	468
Supplies and Equipment -----	1,000
Subtotal -----	37,413
Contingency -----	1,587
TOTAL -----	39,000

\*This budget is for services during a single campaign. Line items should be adjusted accordingly for estimating the total life of project cost of entomological/environmental monitoring services for multiple campaigns.

STATEMENT OF WORK AND ILLUSTRATIVE COSTS  
PESTICIDE MANAGEMENT AND HEALTH/SAFETY SPECIALIST

I. OBJECTIVE

The objective of this procurement is to contract a specialist to provide expert technical assistance to the Government of Morocco (GOM) in the safe management of pesticides being used in its desert locust control program. The ongoing locust control effort involves the use of large quantities of chemical insecticides within a complex distribution and usage network. The scale of the effort, and the fact that it is an emergency operation being conducted on a temporary basis means that a larger than usual number of workers are involved and that comprehensive training in safety and health guidelines for all employees responsible for the management and handling of pesticides is not always feasible. The technical services provided by the Contractor will assist the GOM in safeguarding the health and safety of workers involved in the chemical control aspects of the locust effort as well as the general public; lessen the possibility of accidents involving insecticides; and enhance the GOM Plant Protection Service's emergency response capability.

II. QUALIFICATIONS AND EXPERIENCE

The Contractor shall be a qualified public and occupational health and safety specialist with direct experience in the identification, analysis, and mitigation of public and occupational hazards and health risks associated with use of agricultural insecticides in large scale aerial and ground treatment crop protection programs. The Contractor shall have knowledge of, and experience in safe pesticide management practices for the full life cycle of pesticides used in crop protection programs, including acceptance, transport, storage, aircraft and ground spray operations, and disposal of wastes and empty containers. The Contractor shall be capable of advising the GOM on emergency preparedness and response strategies and procedures. The Contractor shall also have experience in both container and bulk systems for transport, storage, and load-out of pesticides. Developing country experience is highly desirable. French language capability at or above the FSI 3-3 level is required.

III. STATEMENT OF WORK

A. General

The Contractor shall have primary responsibility for advising the GOM Plant Protection Service on matters involving pesticide management, safety,

and health within the overall locust control program. The Contractor shall also advise the GOM Ministry of Public Health concerning development and implementation of programs to minimize health risks to the general public as a result of the locust control effort. An important function of the Contractor shall be to conduct an in-service training program for GOM Plant Protection employees on the safe handling and management of pesticides in the locust control effort. In carrying out these activities, the Contractor will be required to travel to remote field sites under harsh environmental conditions.

#### B. Specific

For each locust control campaign during the life of the project in which such services are deemed necessary, the Contractor shall:

1. Perform a two-day official pre-departure TDY in AID/Washington to receive briefings on the current locust situation and to confer on other project matters with AID/Washington technical and Locust Control Project backstop personnel.
2. Upon arrival in-country, prepare a detailed work plan and schedule for Mission review, setting forth the principal tasks under the scope of work, and how they will be implemented, including identification of all Mission and GOM support and/or coordination which will be required.
3. Analyze the GOM's official guidelines on pesticide safety for crop protection workers in terms of technical adequacy, compliance monitoring, and internal enforcement procedures within the locust control program, and recommend needed changes.
4. Assess the GOM's regulations governing public health protection from exposure to pesticides, especially impacts of crop protection programs employing chemical pest control, and recommend needed changes in regulatory content or provisions for compliance monitoring.
5. Analyze the effectiveness of the Crop Protection Service's locust control pesticide management system by means of extensive site visits to observe the entire pesticide handling network, including receiving (port/airport); temporary storage; transport; warehousing; re-formulation; distribution; use in active locust control areas; and temporary storage/ultimate disposal of wastes and empty containers. Recommend improved procedures as necessary. Attention should be given to appropriateness and adequacy of temporary storage facilities located at remote field sites for use by farmers and/or in ground-application operations, and training needs of personnel responsible for managing such stores.
6. Attempt to inventory the Plant Protection Service's stocks of outdated (or otherwise unusable) pesticides and/or pesticide wastes, including empty containers, and make recommendations for safe and practical disposal of these materials.

7. Analyse the GOM's capability to monitor public health impacts of broadcast insecticide applications in the locust control effort, identify needed improvements, and recommend appropriate actions in response to identified needs.
8. Develop a one or two day in-service training workshop for locust control workers in high pesticide exposure job categories, and stage the workshop at appropriate regional centers in the locust control area. Provide more in-depth "train the trainers" training for a selected number of Peace Corps volunteers, in order to prepare them to provide follow-up training to locust workers serving at remote field sites in the fundamentals of safe pesticide handling and management.
9. Assess the Crop Protection Service's physical infrastructure for worker protection, including shower/change room and laundry facilities; protective clothing and equipment; and firefighting, medical and other emergency response equipment and supplies. Make recommendations for appropriate and practical improvements, as necessary.
10. Review the GOM program for routine whole-blood cholinesterase testing of locust control workers for pesticide exposure, and recommend modifications as necessary.
11. Analyse the Crop Protection Service's plans and preparedness for emergency response to incidents such as chemical spills, fires, and acute pesticide poisoning cases. Identify technical areas or physical locations requiring enhancement and recommend mitigating actions.
12. Verify GOM procedures for destruction of drums originating from USG-provided locust control insecticides, and assess progress in the disposal program.
13. Summarize all data, observations, findings, conclusions and recommendations resulting from the health and safety analyses in a report to be prepared and finalized prior to departure from Morocco. The report shall include a separate section which fully describes all recommended health and safety mitigation actions associated with the Morocco Locust Control effort, including implementation procedures, duration, training requirements, estimated capital and recurrent costs, and agencies responsible for execution. This section shall focus on recommended programmatic interventions on the part of USAID, especially those with management implications, i.e., requiring significant changes in project direction or scope. All recommendations shall, however, be cost effective and implementable under Moroccan conditions.

#### IV. LEVEL OF EFFORT

The estimated level of effort for the Contractor for each locust control campaign (assuming one TDY to Morocco per campaign) is two days in AID/Washington and 28 work days in Morocco (six day work week).

V. ILLUSTRATIVE COSTS\*

<u>ITEM</u>	<u>AMOUNT</u>
Salary - 30 days @ \$260/day -----	7,800
Domestic U.S. travel - one RT Washington -----	750
International travel - one RT U.S./Morocco -----	2,500
In-country travel	
Air -----	1,000
Vehicle rental -----	3,000
Per diem	
Washington - 2 days @ \$117/day -----	234
Morocco - 33 days @ \$78/day -----	2,574
Miscellaneous	
FICA @ 7.5 percent salary -----	585
DBA @ \$2.57/100 salary -----	200
Supplies and Equipment -----	1,000
Subtotal -----	19,643
Contingency -----	1,357
<b>TOTAL -----</b>	<b>21,000</b>

---

\*This budget is for services during a single campaign. Line items should be adjusted accordingly for estimating the total life of project cost of health and safety services for multiple campaigns.

STATEMENT OF WORK AND ILLUSTRATIVE COSTS  
CHOLINESTERASE MONITORING TEST KIT TRAINING CONSULTANT

I. OBJECTIVE

The objective of this procurement is to obtain technical services for training of Government of Morocco (GOM) Ministry of Public Health (MOPH) technicians in the use of an instrument for the measurement of whole-blood cholinesterase levels in workers exposed to pesticides in the course of the GOM locust control program. The instrument to be employed is available in self-contained kit form for use under field conditions by technicians with minimal training. The use of this kit will allow the MOPH to screen workers for cumulative intoxication with cholinesterase-inhibiting pesticides (organo-phosphates and carbamates) and thus prevent potential cases of chronic pesticide poisoning.

II. QUALIFICATIONS AND EXPERIENCE

The Contractor shall be a qualified health scientist/technician well versed in pesticide residue monitoring in biological fluids. The Contractor shall have specific, extensive experience in the use of the "Lovibond" brand colorimetric tintometric whole blood cholinesterase activity measurement kit, or technical equivalent. The Contractor shall also have experience in training technicians in the use of this kit under field conditions in one or more developing countries, and be knowledgeable of the institutional and administrative requirements for implementing a successful and effective national pesticide worker screening program based on use of the Lovibond test kit. Due to the requirement to perform field work in remote locations in Morocco, French language capability at or above the FSI 3-3 level is required.

III. STATEMENT OF WORK

A. General

The Contractor shall be responsible for conducting a training program in the use of the Lovibond test kit for Government of Morocco Ministry of Public Health technicians assigned to the current locust control campaign, and shall advise the MOPH on the development and implementation of a national program for the protection of workers at risk due to high body burdens of cholinesterase-inhibiting pesticides based on data collected using the Lovibond kit. The Contractor shall also advise the MOPH on administrative and management techniques for timely and effective use of worker monitoring results by means of appropriate methods for data management and handling.

## B. Specific

The Contractor shall:

1. Perform a one-day pre-departure TDY in AID/Washington to receive briefings from concerned technical and Morocco Locust Control Project backstop personnel.
2. Upon arrival in-country, prepare a brief work plan and schedule for Mission review, setting forth the principal tasks under the scope of work, and how they will be accomplished, including identification of any Mission and GOM support and/or coordination which will be required.
3. Inspect the consignment of test kits and related commodities procured under the Morocco Locust Control Project in order to verify their condition and suitability for immediate use in the project.
4. Perform an initial training session in Rabat for a core group of senior MOPH technical personnel, covering use of the kit as well as recommendations for collection, management, and use of the data resulting from the national monitoring program. This training session should emphasize fundamentals of Lovibond kit use in order to enable the MOPH core group to assume the training function in subsequent locust control campaigns in Morocco.
5. Travel to up to four regional sites to train field personnel in the use of the Lovibond kit, including methods for interpretation and processing of test results. The training should clearly specify criteria for determining which workers should be tested on a regular basis, and the frequency at which testing should occur.
6. Brief Mission and MOPH personnel upon conclusion of the field training program, to identify any constraints to implementation of the monitoring program and to make recommendations for prevention of potential problems.
7. Advise MOPH management on appropriate approaches for utilizing data collected in the pesticide worker monitoring program. Specific guidance shall be provided on criteria for using test results to identify workers at risk due to excessive pesticide exposure, and management alternatives for effectively removing such persons from chemical exposure for an adequate amount time to allow de-toxification.
8. Prior to departure from Morocco, prepare a letter report to the USAID Project Officer, summarizing relevant findings, conclusions, and recommendations, including a proposed procurement plan and schedule for replacement reagents and test kit expendables.

#### IV. LEVEL OF EFFORT

The estimated level of effort for the Contractor is one day in AID/Washington and 17 work days in Morocco (six day work week).

#### V. ILLUSTRATIVE COSTS

<u>ITEM</u>	<u>AMOUNT</u>
Salary - 18 days @ \$260/day -----	4,680
Domestic U.S. travel - one RT Washington -----	750
International travel - one RT U.S./Morocco -----	2,500
In-country travel -----	
Air -----	850
Vehicle rental -----	2,800
Per diem -----	
Washington - 2 days @ \$117/day -----	234
Morocco - 21 days @ \$78/day -----	1,638
Miscellaneous -----	
FICA @ 7.5 percent salary -----	351
DBA @ \$2.57/100 salary -----	120
Subtotal -----	13,923
Contingency -----	1,077
TOTAL -----	15,000

STATEMENT OF COMMODITY REQUIREMENTS, SPECIFICATIONS AND COSTS  
CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT FOR  
LOCUST CONTROL FIELD WORKERS HANDLING PESTICIDES

I. OBJECTIVE

The objective of this procurement is to provide the Government of Morocco Plant Protection Service with appropriate protective clothing and equipment for use by workers exposed to pesticides in the course of the locust control effort. This equipment is intended for use by workers at risk due to high and/or long-term exposures, i.e., formulators, aircraft loading and service crews, mist blower operators, etc.

II. SPECIFICATIONS

A. Head/Eye Protection

- Hard hat of a general industrial occupational standard, adjustable size, international orange or other high-visibility color;
- Swing-down full face visor attached to hard hat, clear, chemical resistant plastic, for splash hazard protection.

B. Respiratory Protection

- U.S. Mining Safety Administration "Comfo Flo 11" respirator or equivalent, with organic vapor cartridges;
- Replacement cartridges for above.

C. Clothing

- Long sleeved heavy-duty serviceable coverall, tightly woven chemical and fire resistant fabric, international orange or other highly visible color, size medium;
- Elbow-length gauntlet-type work gloves, chemical-resistant (neoprene or natural) rubber, unlined, size medium;
- Knee-high work boots, chemical-resistant (neoprene or natural) rubber, steel toe, unlined, size medium.

III. QUANTITIES AND ILLUSTRATIVE COSTS

The quantities presented below are preliminary recommendations based on an estimate of the GOM's actual needs, taking into account contributions to-date from other donors.

<u>ITEM</u>	<u>AMOUNT</u>
Head/Eye Protection - 200 units @ \$50 -----	1,000
Respiratory Protection - 200 units @ \$50 -----	1,000
Replacement cartridges - 1,000 units @ \$2 -----	2,000
Clothing - 200 complete sets @ \$150 -----	30,000
Shipping and handling - 10,000 lbs @ \$1.00/lb -----	10,000
TOTAL -----	44,000

STATEMENT OF COMMODITY REQUIREMENTS, SPECIFICATIONS, AND COSTS  
CHOLINESTERASE MONITORING TEST KITS

Objective: The objective of this procurement is to provide the Government of Morocco (GOM) Ministry of Public Health (MOPH) with an instrument for the measurement of whole-blood cholinesterase levels in workers exposed to pesticides in the course of the GOM locust control program. The instrument to be employed is available in self-contained kit form for use under field conditions by technicians with minimal training. The use of this kit will allow the MOPH to screen workers for cumulative intoxication with cholinesterase-inhibiting pesticides (organo-phosphates and carbamates) and thus prevent potential cases of chronic pesticide poisoning.

Manufacturer: See attached literature.

Supplier: See attached literature.

Specifications: See attached literature.

Items and Quantities to be Procured, with Illustrative Costs:

<u>ITEM</u>	<u>AMOUNT</u>
Test Kits 15 @ \$675 -----	10,125
Reagents Bromothymol blue ampules - 2000 @ \$9/500 -----	36
Other Expendables Blood lancets - 30,000 @ \$25/1000 -----	750
Test tubes - 150 @ \$8 -----	1,200
Test tube brushes - 30 @ \$2 -----	60
Stirring rods - 15 @ \$3 -----	45
Fused glass cells - 15 @ \$18 -----	270
Vol. pipettes (0.01 ml) - 5000 @ \$80/1000 -----	400
Shipping and Handling (air freight) 250 lbs @ \$3.50/lb -----	875
TOTAL -----	13,761

1082e