AGENCY FOR INTERNATIONAL DEVELOPMENT

Washington, D. C. 20523

PROJECT PAPER

Amendment #1

MOROCCO: Locust Control Project
(608-0196)

February 10, 1989

LOCUST CONTROL PROJECT PAPER

AMENDMENT

(608-0196)

USAID/MOROCCO

DECEMBER, 1988

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: C (A = Add, C = Change, D = Delete) — Amendment Number

DOCUMENT CODE: 3

2. COUNTRY/ENTITY: MOROCCO

3. PROJECT NUMBER: 608-0196

4. BUREAU/OFFICE: ANE — 608

5. PROJECT TITLE (maximum 40 characters): Morocco Locust Control Project

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 06 DD 30 YY 91

7. ESTIMATED DATE OF OBLIGATION (Under 'B.' below, enter 1, 2, 3, or 4)
A. Initial FY 88 B. Quarter 2 C. Final FY 90

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY 88 B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total						
(Grant)	( )	( )	(3,500)	( )	( )	(23,500)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country			40,000			140,000
Other Donor(s)						
TOTALS			43,500			163,500

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) ESF		070		3,500		20,000		23,500	
(2)									
(3)									
(4)				3,500		20,000		23,500	
TOTALS									

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each)

11. SECONDARY PURPOSE CODE

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)
A. Code
B. Amount

13. PROJECT PURPOSE (maximum 480 characters)

To assist the Government of Morocco, in coordination with other Donors, to control desert locusts.

14. SCHEDULED EVALUATIONS
Interim MM YY MM YY Final MM 06 YY 91

15. SOURCE/ORIGIN OF GOODS AND SERVICES
☒ 000 ☐ 941 ☒ Local ☐ Other (Specify)

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a ____ page PP Amendment.)

This Amendment updates all project analyses, increases LOP funding by $20,000,000 and extends the PACD to 6/30/91.

USAID/Morocco Controller's approval of proposed methods of implementation and financing.

Signature: Richard L. Warren Title: Controller

17. APPROVED BY
Signature: Charles W. Johnson
Title: Director USAID/Morocco
Date Signed: MM 06 DD 10 YY 89

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION
MM DD YY

AID 1330-4 (8-79)

TABLE OF CONTENTS

			Page
		Action Memorandum to the USAID/Morocco Director	i
		Project Authorization	iii
		List of Project and Mission Review Committee Members	iv
		Acronyms	v
I.		SUMMARY AND RECOMMENDATIONS	1
	A.	Summary Background	1
	B.	Summary Project Description	1
	C.	Summary Financial Plan	3
	D.	Recommendations	4
II.		BACKGROUND/RATIONALE	5
	A.	The Locust Problem	5
	B.	Relationship to CDSS and GOM Development Plan	11
III.		DETAILED PROJECT DESCRIPTION	12
	A.	Project Goal	12
	B.	Project Purpose	12
	C.	Project Outputs	12
	D.	Project Inputs	12
	E.	Project Organization, Strategy and Activities	12
IV.		FINANCIAL PLAN	15
V.		IMPLEMENTATION AND PROCUREMENT PLANS	19
	A.	Implementation Arrangements	19
	B.	Procurement Plan	19
VI.		MONITORING AND EVALUATION PLAN	26
	A.	Monitoring and Assessment	26
	B.	Evaluation	26

VII. SUMMARY OF ANALYSES 27

A. Summary Economic Analysis 27
B. Summary Environmental Analysis 30
C. Summary Technical Analysis 32
D. Institutional Analysis Update 35

VIII. SPECIAL COVENANTS 37

A. Pesticides 37
B. Pesticide Drum Disposal 37
C. Geographical Limits of Aerial Spraying Operations 37
D. Navigational Maps and Briefings 37
E. Redeployment of Aircraft 37

ANNEXES

Annex A Logical Framework
Annex B Economic Analysis
Annex C Environmental Analysis
Annex D Technical Analysis
Annex E Redelegation of Authority Cable
Annex F Procurement Source/Origin Waiver
Annex G Decis Waiver
Annex H Statutory Checklists
Annex I GOM Request for Assistance
Annex J Map of Affected Area
Annex K Class Justification for Other than Full and Open Competition

ACTION MEMORANDUM TO THE MISSION DIRECTOR

FROM: John Wiebler, Acting Program Officer

SUBJECT: The Morocco Locust Control Project Paper Amendment

PROBLEM: Your approval is required for the subject Project Paper Amendment and Project Authorization Amendment.

DISCUSSION: This Project Paper Amendment responds to the continuing need for USAID support to the GOM locust control operation. The severity of the locust infestation in the Maghreb continues to threaten Moroccan agriculture. It is estimated that the current invasion which began in October 1988 is ten times greater than the one last year, and that a serious threat will continue through January 1989. If adequate rainfall occurs in southern Morocco and northwestern Mauritania in January and February 1989, up to 2 million hectares of hopper bands could develop in that region alone. Extrapolating from this number, experts predict that 2 to 20 million hectares of locusts could invade southern Morocco and migrate north into the agricultural zones of the Souss valley. The threat that many may cross the High Atlas Mountains and severly damage crops in the north-west of Morocco is very real.

The goal of the Morocco Locust Control Project continues to be the protection of Moroccan crops and livestock from the locust plague in ways consistent with protecting the health and well-being of the people and the environment of Morocco. The purpose of the Project is to assist the Government of Morocco, in coordination with other donors, to control desert locusts.

With this Amendment, the Project will: 1) enhance GOM capacity to control desert locusts through aerial spraying of insecticides; 2) improve strategic planning and tactics of control operations, including preparation for appropriate responses north of the Atlas Mountains if necessary; 3) improve efficiency of operation — survey, treatment and communications —; and 4) improve GOM capacity for the management and monitoring of environmental safety and health aspects of control operations.

Project inputs include the flight time of Turbo-Thrush and DC-7 aircraft; insecticides; safety, health, environmental and logistic support commodities; and, technical assistance and training.

The Mission Review was held on December 22, 1988. At that time, the Mission Review Committee recommended that the project be approved, subject to non-substantive corrections being made to the Project Amendment text.

This Project Paper Amendment is the first such document to be prepared for authorization this fiscal year. An updated Country Cheklist was accordingly requested and prepared in AID/W. The ANE/MENA Desk Officer has reviewed the Country Checklist and advised that no legislative prohibitions to project approval exist.

The Congressional Notification expired without comment on December 20, 1988.

A Source and Origin Waiver for the procurement of 20 Cholinesterase Monitoring Test Kits and related training services at an approximate cost of $ 37,500 is attached for your approval.

Recommendations:

1) That, according to the authority granted to you in AID Delegation of Authority 654, you approve the Morocco Locust Control Project Paper Amendment by signing the Project Amendment Data Sheet;

2) That you sign the attached Project Authorization Amendment for a life-of-project total of $23,500,000 and a PACD of June 30, 1991; and

3) That you sign the attached Procurement Source/Origin Waiver for the procurement of 20 Cholinesterase Monitoring Test Kits and related training services .

APPROVED: Charles W. Johnson DATE: 2/10/89 DISAPPROVED: _____

Charles W. Johnson
Director

Drafted BY:PDO:ABraginski:12/28/88 AB

Clearances: Belinda Barrington, RLA BLB
Rollo Ehrich, AGR RBS
Richard Warrin, CONT
Linda Morse, D/DIR

AMENDMENT NO. 1 TO PROJECT AUTHORIZATION

Name of Country: MOROCCO

Name of Project: Locust Control

Number of Project: 608-0196

1. Pursuant to Section 531 of the Foreign Assistance Act of 1961, as amended, the Locust Control Project for Morocco (Cooperating Country) was authorized on May 11, 1988. That Authorization is hereby amended to increase the level of planned obligations from not to exceed $3,500,000 to not to exceed $23,500,000 in Economic Support Grant Funds.

2. The Authorization cited above remains in force except as hereby amended.

Charles W. Johnson
Director

Date: 2/10/89

USAID PROJECT DESIGN COMMITTEE

Robert Hellyer	Agriculture Project Officer
Ronald Stryker	Deputy Agriculture Development Officer
Joe Kitts	Project Coordinator
Aleksandra Braginski	Project Development Officer
Daniel Kohler	Program Economist
Eric Loken	Mission Environmental Officer

MISSION REVIEW COMMITTEE

Charles Johnson	Director
Linda Morse	Deputy Director
John Wiebler	Program Officer
Rollo Ehrich	Agriculture Development Officer
Richard Warin	Controller
Belinda Barrington	Regional Legal Advisor

LIST OF ACRONYMS

AFR	Africa Bureau
ANE	Asia and Near East Bureau
CDSS	Country Development Strategy Statement
CFR	Code of Federal Regulations
DDVP	2,2-Dichlorovinyl Dimethyl Phosphate (Dichlorvos)
EA	Environmental Assessment
EEC	European Economic Community
ESF	Economic Support Fund
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GSA	General Services Administration
HF	High Frequency
IQC	Indefinite Quantity Contract
OFDA	Office of Foreign Disaster Assistance
PC	Poste de Commande
PCC	Poste de Commande Centrale
PID	Project Identification Document
PM	Person-Month
PP	Project Paper
PSA	Procurement Services Agent
USAID	United States Agency for International Development
SER	Program and Management Services Burerau
TA	Technical Assistance

I. SUMMARY AND RECOMMENDATIONS

A. Summary Background

For the first time in twenty years, in 1987, Desert Locusts entered Morocco, threatening disaster and significant agricultural losses. Control efforts in Morocco were launched in the fall of 1987. Between January and June 1988 the Maghrebian countries - Morocco, Algeria, Tunisia, Libya and Mauritania - treated nearly 5 million hectares of locust swarms.

Despite the magnitude of the control effort, intense breeding occured in southern Morocco and southern Algeria in April 1988. Many hoppers escaped treatment. Untreated hoppers reached adulthood by June and immediately began migrating to the south with the onset of the dry season in Morocco and Algeria. By July all locusts in the Maghreb had either been effectively treated or had escaped treatment and subsequently migrated south to Mauritania and the Sahelian countries.

In June 1988, rains provided favorable climatic conditions for locust breeding and survival throughout a vast area of the Sahel. Both residual locusts in this recession region plus those which escaped from the Maghreb were able to find extensive areas for breeding. A new generation of hoppers was thus produced throughout the countries of Chad, Northern Nigeria and Mali, extreme southern Algeria and southern Mauritania. By August, yet another generation was created. It is estimated that over 5 million hectares were infested in these countries. By early September 1988, the population explosion had left a belt of late instar hopper bands (ready to be airborne in days) stretching from Sudan to southeastern Mauritania. Experts were predicting that if 10 percent of the hoppers survived and fledged, the worst infestation since the last plague would occur. The population explosion was vast and the control efforts undertaken by the Sahelian countries had virtually no impact.

During late September and early October 1988, locusts from the Sahel migrated back north toward the Maghreb and entered Morocco. The situation in Morocco was extremely dangerous in late October and early November. A total of 1.2 million hectares were treated between October 10 and December 1. This current invasion is estimated to be ten times greater than the one last year and will remain as a serious threat to Morocco through June 1989.

If adequate rainfall occurs in southern Morocco and northwestern Mauritania in January and February 1989, up to 2 million hectares of hopper bands could develop in that region alone. Extrapolating from this number, experts predict that 2 to 20 million hectares of locusts could invade southern Morocco and migrate north into the agricultural zones of the Souss valley. The threat that significant numbers of swarms may cross the High Atlas Mountains and severly damage crops in the northern regions of Morocco is very real.

B. Summary Project Description

The goal of the Morocco Locust Control Project is to protect Moroccan crops and livestock from the locust plague in ways consistent with protecting the health and well-being of the people and the environment of Morocco. The

purpose of the project is to assist the Government of Morocco, in coordination with other donors, to control desert locusts from January 1988 through June 1991.

The project will provide airplane flight hours; insecticides; health, safety, and environmental related commodities; logistical support commodities; and technical assistance and training. Based on the strategy currently employed in fighting the locusts, the project will provide an assistance package for each campaign. It is extremely difficult to predict the future magnitude of locust invasions, and hence, the specific nature of USAID assistance. The project will threfore utilize a flexible design based on periodic assessments to refine the assistance package.

Project activities for the current campaign (January - June 1989) are: (1) Two Turbo-Thrush aircraft will be leased from January through June 1989, and (2) Two four-engine aircraft (DC-7s) will be leased during March through June 1989. As locusts numbers are expected to increase dramatically in the March-June 1989 period, following egg-laying and hatching in northwestern Mauritania and in other regions outside Morocco, there may be a need to lease additional aircraft such as two additional four-engine aircraft and two Turbo-Thrushes. (3) Four-hundred thousand liters of insecticide will also be procured by March 1989. (4) Other critical support commodities, including radios, greenness maps, and insecticide transfer equipment, will be procured by March 1989 in order to augment overall operational efficiency. (5) An improved environmental program will be in place by March 1989 including procurement of associated environmental, health and safety commodities, cholinesterase kits, protective clothing and fire equipment. (6) Finally, selected technical assistance and training for insecticide handling, insecticide efficiency testing, calibration testing, survey team training and other activities are be scheduled between February and September 1989.

Specific activities to be funded by A.I.D. for the 1990 and 1991 campaigns have not been fully determined. Prior to each campaign an assessment will be undertaken by the GOM and USAID to determine the specific nature and level of assistance needed. Activities will likely be essentially the same as those described above.

Project Outputs are:

(1) enhanced GOM capacity to control desert locusts through aerial spraying of insecticides;

(2) improved strategic planning and tactics of control operations, including preparation for appropriate responses north of the Atlas Mountains if necessary;

(3) improved efficiency of operations -- survey, treatment and communications --; and

(4) improved GOM capacity for the management and monitoring of environmental, safety and health aspects of control operations.

PROJECT FINANCIAL PLAN
USAID/MOROCCO
LOCUST CONTROL PROGRAM (608-0196)

SOURCE & APPLICATION OF FUNDING

C. Summary Financial Pl

1. AID Contribution

PROJECT INPUTS	AMOUNT PREVIOUS PROAG	AMOUNT THIS AMENDMENT	CUMULATIVE 1 OBLIGATIONS (AS OF 1/1/89) AID	ANTICIPATED 2 OBLIGATIONS AID	TOTAL LOP AID
1 AIRCRAFT	593,450	4,160,000	4,753,450		
2 PESTICIDES	1,448,932	3,400,000	4,848,932		
3 SPRAY SYSTEMS	312,500	0	312,500	--	--
4 MISCELLANEOUS COMMODITIES	177,500	0	177,500	--	--
5 ENVIRONMENTAL HEALTH&SAFETY COM.	0	392,000	392,000	--	--
6 LOGISTIC COMMODITIES	0	539,000	539,000	--	--
7 TRAINING & TECHNICAL ASSISTANCE	77,500	850,000	927,500	--	--
8 AUDIT	0	0	0	--	--
9 CONTINGENCIES	890,118	659,000	1,549,118	--	--
			0		
TOTAL	3,500,000	10,000,000	13,500,000	10,000,000	23,500,000

1/ estimated to cover costs of elements through December, 1989
2/ to be determined based on assessments

2. GOM Contributions

The GOM anticipates spending approximately 216 million DH or $26.6 million for the current campaign through December 1988. The GOM contribution to the 1989 Spring and Fall Campaigns (January - December 1989) is projected to be $50.0 million.

3. Other Donor Contributions

The donor community has contributed approximately 70 million DH or $5.0 million for the current (October 1988 - December 1989) campaign. It is expected that the donor community will contribute approximately $20.0 million during 1989.

D. Recommendation

The USAID Project Committee has determined that the proposed activities are technically, administratively, and financially appropriate and feasible for successful implementation and accomplishment of stated objectives within the extended life of project.

II. BACKGROUND/RATIONALE

A. The Locust Problem

1. The Nature of the Locust Cycle

Locusts have caused concern since the beginning of recorded history. The most feared of all the locusts worldwide is the Desert Locust. Depending on the duration and severity of attack, economic loss may vary from isolated farmers losing a portion of a crop to the destruction of the food supply of an entire region. The total area invaded during Desert Locust plagues can extend over 29 million sq. km. and involve more than 60 nations. Once a population reaches plague status throughout the invasion area, the probability that it can be lowered to a recession level by other than natural means decreases.

Unlike other locusts, the Desert Locust becomes gregarious[1/] and migratory during population explosions. Between plagues, the Desert Locust reverts to the solitary phase with low population levels in the recession area of approximately 14 million sq. km. of the Sahel. Within this recession area are a number of locations that are considered primary breeding and reproduction grounds. These include the Red Sea, coastal areas of Sudan and Ethiopia, the northern Somalia coast, Tibesti mountains of Chad, Air of Niger, Adrar des Iforas of Mali, and Ahaggar of Algeria. During population build-up, control in these breeding areas has been extremely difficult or impossible due to a variety of political and security constraints, as well as limitations in national crop protection services. With favorable moisture conditions, widespread, uncontrolled breeding in the recession area can result in population explosions, leading to plagues.

The Desert Locust can propagate from 10 to 100 times per generation with as many as 6 generations per year. Crowding for more than one generation is required to produce the fully gregarious characteristics of plague proportions. Crowding occurs when either a favorable habitat allows for the production of several successive generations in the same area, or when a partially gregarious population moves to an alternative seasonal breeding area with conditions continuing to favor reproduction and gregarious behavior. The Desert Locust is known for its long-range pattern of migration of as much as several thousand kilometers within a single generation. During non-plague cycles, the population reverts to a partially or wholly solitary phase which is characterized by slower reproduction and maturation rates.

2. The Regional Problem in Africa

For the first time in twenty years, in 1987, Desert Locusts entered Morocco, threatening disaster and significant agricultural losses. Swarms of locusts, which had migrated from Chad, invaded Niger in early Summer, 1987 and then moved into Morocco and the rest of the Maghreb. It is believed that the population build-up began in northern Ethiopia. Control efforts in Morocco

1/ Gregarious - habitually living in swarms during population build-up.

were launched in the fall of 1987. Between January and June 1988, the Maghrebian countries - Morocco, Algeria, Tunisia, Libya and Mauritania - treated nearly 5 million hectares of locust swarms.

Despite the magnitude of the control effort, intense breeding occurred in southern Morocco and southern Algeria in April 1988 and many hoppers[2/] escaped treatment. Untreated hoppers reached adulthood by June and immediately began migrating to the south with the onset of the dry season in Morocco and Algeria. No locusts were observed in the Maghreb during the summer months of July, August and September. By July all locusts in the Maghreb had either been effectively treated or had escaped treatment and subsequently migrated south to Mauritania and the Sahelian countries.

In June 1988, the intertropical pressure front moved up to the 16th parallel, initiating widespread rains throughout the Sahelian countries. The rains provided favorable climatic conditions for locust breeding and survival throughout a vast area of the Sahel. Both residual locusts in this recession region plus those which escaped from the Maghreb were able to find extensive areas for breeding. A new generation of hoppers was thus produced throughout the countries of Chad, Northern Nigeria and Mali, extreme southern Algeria and southern Mauritania. By August, yet another generation was created with estimates of over 5 million hectares infested in these countries. By early September 1988, the population explosion had left a belt of late instar[3/] hopper bands (ready to be airborne in days) stretching from Sudan to southeastern Mauritania. Experts were predicting that if 10 percent of the hoppers survived and fledged, the worst infestation since the last plague would occur. The population explosion was vast and the control efforts undertaken by the Sahelian countries had virtually no impact.

During late September and early October 1988, the intertropical front moved south again bringing dryer weather into the Sahel. At that point in time, the now adult locusts began swarming and migrating. Those from the western Sudan and the Sahel began moving westward and north toward the Maghreb, while those in Eastern Sudan moved to the east toward the Red Sea coast in Ethiopia and Yemen, and many eventually even crossed the Red Sea. By the end of September, locust infestations existed in Southern Mauritania, Senegal, Niger, Mali, Chad, Burkino Faso, Sudan, Saudia Arabia, Ethiopia, Yemen, Pakistan and the Cape Verde Islands. A major swarm also blew off the west coast of Africa in September and ultimately broke up, but remnants of this swarm reached as far as the Carribean Islands. Remnants of yet another swarm were sighted in England about the same time.

Locust disasters had been declared by most of the U.S. Embassies in the affected countries during this period. Control efforts were mounted by USAID missions, with help from host countries, FAO and other donors. However, these control efforts in the Sahel did little to abate the locust problem. Most experts now agree that attempts to launch effective control campaigns in the

2/ Hopper - immature form of locust prior to forming functional wings as an adult. Hoppers also become gregarious (hopper bands).

3/ Instar - one of five immature forms (hopper) between successive moults.

recession areas of the Sahelian region have been ineffective in suppressing the total population, but crop loss was probably reduced in some areas. Moreover, it is unlikely that future efforts to control locusts in the Sahel will be effective because of the enormous area now affected and the inability of host countries and international organizations such as the FAO to develop the required capacity to treat the critically affected areas at the right time. The required level of logistical coordination, number of survey teams needed, difficulty of access to critical areas, and the resources needed in the Sahel present constraints which, thus far, have not been overcome.

In early October 1988, Morocco braced itself for a massive migration through the Mauritanian corridor. Locust infestations covering 4 million hectares in Mauritania, 2 million in Senegal and 500,000 hectares in Mali were expected to reach the Maghreb. Unknown numbers from Niger and Chad were also expected to migrate north to Morocco.

Depending on rainfall, it is estimated that between 200,000 to 2 million hectares in northern Mauritania and the southern Sahara could potentially provide habitat for egg-laying during December and early January 1989, with hoppers emerging from this region by late January 1989. Of this potential, recent prospection (early December) by locust experts confirm that at least 150,000 hectares near Bir Maghrein is suitable for reproduction and vegetation is more abundant than in 1987. Greenness maps of the December, 1988 period also reveal large potential breeding areas in Mauritania near Ain Ben Tilli and northwest of Zonamet in the Western Sahara. Although these areas now appear to be drying somewhat, adequate perennial vegetation is present to perpetuate the locust population. The insects are expected to reach maturity, and unless effectively treated, the hoppers could multiply ten-fold, creating 2 to 20 million hectares of swarms which will reach Morocco and subsequently spread throughout the Maghreb by March 1989. Twenty million hectares would represent a ten-fold increase in the swarms reaching Morocco compared with the same period last year.

3. Update of Problem in Morocco

Morocco has experienced three separate locust invasions since October 1987. Of these only the last invasion in September 1988 had been fully anticipated.

a. Recent Past (October 1987 - June 1988)

The first locust invasion for which USAID invoked emergency relief through OFDA, began in late October 1987 and ended in January 1988. During this period, a total of 179,095 hectares were treated in the zones south of the Anti-Atlas mountains (Tan-Tan, Guelmin, Tata) and east of the High Atlas mountains (Ouarzazate, Zagora, Errachidia and north-east Bouarfa).

The second invasion, also requiring USAID emergency relief through OFDA, began in early March 1988 and ended in late June 1988. Unfortunately, the GOM was not fully aware of the severity of the infestation which developed over the January-February 1988 period in north-west Mauritania. This was due to the lack of adequate and timely prospection and surveillance. Abundant

rainfall provided adequate vegetation and humid soil conditions allowing locusts to breed and reproduce. An estimated 300,000 to 500,000 hectares of hoppers developed in this area. Of the resulting 5 million hectares[4/] of swarms, approximately 2.5 million hectares invaded Morocco, with Algeria and Tunisia receiving 1.8 million and 700,000 hectares respectively. In early March, sexually mature, bright yellow, gregarious desert locusts began to move northward into the Guelmin and Tata areas. By the end of the month additional swarms were sighted near Zagora, Ouarzazate, Errachidia and Bouarfa.

These yellow, breeding locusts were less voracious than they were in their pink, immature adult stage. Because of the suitable climatic conditions (ie. ideal soil, moisture, temperature and vegetation) that existed south of the Anti-Atlas mountains, the females laid at least twice and very likely 3 times over a 6 to 10 day interval. Fifty to eighty eggs were detected with each laying, or about 200 eggs total per female. Dissection of a large number of females failed to reveal any reabsorption of eggs, so a full complement of eggs were laid from those female locusts not controlled in advance of egg-laying.

The influx of new swarms in March 1988 was beyond the control capabilities of the GOM. To expand the control efforts, the GOM requested and obtained from USAID and other donors additional highly maneuverable aircraft (medium size class) with sufficient range and power to work in rugged terrain. USAID declared an emergency and worked with OFDA to obtain Turbo-Thrush aircraft and insecticides. Soon after, USAID signed a bilateral project agreement to continue funding the control activities.

Effective control of the adult swarms during the early part of March reduced the potential size of the next generation and thereby limited crop damage. Nevertheless, enough eggs were laid that, given the ideal soil moisture and temperature conditions, a large larval population emerged during late March through May. At the end of March, egg-laying was essentially complete and natural mortality due to old age had already begun. Since there has been no significant Desert Locust population in Southern Morocco for many years, the area is practically devoid of principal parasites and predators, which might have otherwise contributed to reduce the locust population.

Despite control efforts, a major population upsurge from the hopper generation occurred from March through June 1988. During the Spring 1988 campaign, a total of 1,432,842 hectares were treated for control of swarms and a total of 1,201,245 hectares were treated for hopper bands. Experts believe that the majority of all hopper bands were effectively controlled in the accessible treatment areas in Morocco. However, it is believed that egg-laying ocurred and subsequent swarms developed and escaped from inaccessible areas in western Sahara in late June 1988 and returned to the Sahel summer recession breeding areas. During the same period, the treatment of approximately 2.4 million hectares in the other Maghrebian countries did not prevent escapes to the summer recession breeding areas in the Sahel, further augmenting the magnitude of breeding and potential reinvasion of the north.

4/ Under favorable conditions, experts believe that one hectare of hopper bands results in approximately 10 hectares of swarms.

b. Present (October 1988 - June 1989)

As predicted, locust invasions began in Morocco again in late September 1988. Locust swarms were sighted in the extreme southern regions of Morocco on September 29, 1988. Treatment began on October 10 in the Laayoune and Smara areas of the Western Sahara. By October 15, ground and aerial operations had begun in the Oujda, Bouarfa, Errachidia, Ouarzazate, Tata and Guelmin areas. Average daily treatment increased from 5-10,000 hectares per day in early October to 30-40,000 hectares in late October.

The situation was extremely dangerous between October 31 to November 4. The resumption of hot, southerly winds and continued lack of vegetation between Senegal and Morocco brought waves of even larger swarms. The locust invasion soon outstripped the GOM's 30-40,000 hectares per day capacity, and the GOM requested two DC-7 aircraft from USAID. Their arrival on November 10 boosted daily treatment capacity to 70,000 hectares per day. This capacity still fell short of the GOM's estimated 100,000 hectares per day rate of invasion.

Between October 10 and December 19, a total of 1,600,000 hectares have been treated. The present invasion is more than 10 times greater than that experienced in the Fall 1987 campaign. The GOM has committed $26 million to support 44 aircraft and 3,300 persons working out of 12 regional command posts for the Fall 1988 campaign.

The GOM believes a serious threat will exist through June 1989 as large swarms continue to move north from Mauritania and West Africa. If there is a lack of vegetation in north-western Mauritania, swarms will continue to move into Morocco and will threaten major irrigation zones such as the Souss-Massa Valley, a major producer of high-value agricultural exports.

Over 250,000 hectares have been treated thus far within the Souss-Massa Valley alone. Experts predict that if swarms move into the irrigated areas where temperatures and humidity are favorable for locust development, major crop damage will occur. Worse yet, breeding and egg-laying will follow and create a new generation. However, if adequate rainfall occurs in North Western Mauritania, experts believe conditions will favor recession breeding. It is currently estimated that up to 2 million hectares could provide habitat for egg-laying and emerging hopper bands. Breeding and hopper band development occurred in the same area between January and February 1988. However, the magnitude of the resulting influx of swarms in March 1989 through June 1989 is expected to be substantially greater than that which hit Morocco the previous Spring. It is assumed that the influx will be distributed over the Maghrebian countries, with 2 to 20 million hectares worth of locusts migrating into Morocco. This level of infestation would represent roughly a 10-fold increase over the Spring 1988 campaign.

c. Future (October 1989 - June 1990)

The ability to reasonably predict the timing and severity of upcoming locust invasions is based on knowledge of the immediate, previous three to four months period. Within this time-frame, the general magnitude of locust

populations that may invade any given region is based on knowledge of habitat conditions (rainfall, vegetation) where locusts exist, surveys in the affected region, and knowledge of the migration pattern (linked to regional climatic conditions of temperature, rainfall and prevailing winds).

For periods longer than 3-4 months, predictions are more difficult to make with accuracy. This point can be illustrated in terms of the relationship between the Sahelian recession regions and its effect on subsequent winter migration to the Maghreb. If, for example, a drought affected the Sahelian summer recession breeding habitats, reproduction would be seriously restricted and the resulting populations eventually moving north to the Maghreb would be reduced. The point being that the potential populations which are likely to move toward Morocco in October cannot be reasonably estimated until about August when knowledge of the actual Sahelian reproduction is acquired. On the other hand, it is known that populations have expanded enormously over the last year and a half and have created a plague situation. The biological significance of this is that locusts have now expanded their numbers and their habitat range into other countries, regions where they would not otherwise be found during a non-plague period. Thus, sheer numbers, and greater access to habitat increase the probability of continued survival, even when localized habitat conditions affecting their survival become unfavorable.

Past plagues have tended to last 7 to 10 years before coming to a natural end. Natural termination of plagues usually results from a combination of events such as increased natural parasites and diseases and major changes in habitat, affecting locust survival and factors such as drought, affecting reproduction.

Locust experts believe the current plague could be broken if action is taken now. The plague is still in an early stage and populations are, at least, potentially treatable, if offensive action is targeted to critical areas. Given the potential population expansions that can occur, the plague could reach unmanageable proportions over the next year or two. Thus, it is critical to mount a major international offensive action in critical regions where locusts concentrate.

If the plague cannot be broken by an international treatment program, then it can be expected that the regional locust cycle will continue to have a multiplying effect and the plague will become more severe. The only possible natural event which could change this scenario would be a major drought in the Sahelian summer breeding zones. Over the longer time frame, the plague would eventually diminish as other natural parasites and diseases, as well as environmental factors, mitigate against the large locust populations.

For Morocco, locust invasions into Morocco will begin again in October of 1989 and will last through June 1990. The nature of the invasion, such as entry points, timing, biological cycle, and local climatic conditions can be expected to be similar to those experienced in October 1987 and October 1988. (see Technical Analysis Sec. VI.C.1.). What cannot be predicted at this time is the magnitude of the invasion. However, it is more likely that the invasion will be larger, rather than smaller, as compared to the current 1988-89 level of the plague.

B. Relationship to CDSS and GOM Development Plan

The major objective of USAID Morocco's agricultural strategy is to improve agricultural productivity. Toward this end, A.I.D. is financing agricultural education, agricultural research, improved agricultural planning and economic analysis, agricultural credit as well as supplemental irrigation. If locusts invade Morocco and destroy significant crops, then both USAID's and GOM's agricultural strategies will be seriously threatened.

III. DETAILED PROJECT DESCRIPTION

A. Project Goal

The goal of the USAID Morocco Locust Control Project is to protect Moroccan crops and livestock from the locust plague in ways consistent with protecting the health and well-being of the people and the environment of Morocco.

B. Project Purpose

The purpose of the project is to assist the Government of Morocco, in coordination with other donors, to control desert locusts.

C. Project Outputs

Principal project outputs are:

(1) enhanced capacity to control desert locusts through aerial spraying of insecticides;

(2) improved strategic planning and tactics of control operations, including preparation for appropriate responses north of the Atlas mountains if necessary;

(3) improved efficiency of operations -- survey, treatment and communications; and

(4) improved GOM capacity for the management and monitoring of environmental, safety and health aspects of control operations.

D. Project Inputs

Inputs include: (1) rental of aircraft, (2) insecticides, (3) technical assistance, training and selected commodities for improving the handling and use of insecticides; safety equipment; ground surveillance; ground to air communication; and control strategies; and (4) environmental monitoring systems.

E. Project Organization, Strategy and Activities

1. Organizational Aspects

The Moroccan Government has developed and continues to improve their institutional framework for combating the desert locust. The project will continue to work within the institutional structure which is described in the Institutional Analysis of the original Project Paper and updated below in Section VII, D. of this Project Paper Amendment.

2. Project Design Strategy

The Project will continue to assist the GOM in its battle against locust

invasions and endemic population build-ups as they occur. It is extremely difficult to predict the magnitude of locust invasions more than a few months in advance. Therefore, the project will continue to respond flexibly to periodic assessments of the locust problem to specify assistance requirements for each campaign. The assessments will be conducted jointly by USAID and GOM and will serve to refine the assistance package to fit emerging needs.

Campaign periods are defined as successive October - June periods. Assessments will be conducted during the summer months between control campaigns, June through September, and during the lull in campaign activities which usually occurs between late December and early March. The summer operational down-time will also be used to provide technical assistance and training in areas which are not absolutely essential to the conduct of actual control operations, ie. training of pilots, insecticide handlers, survey strategies, ground to air communication systems, and environmental research.

3. Project Activities

3.1 Based on periodic assessments, the project will provide aircraft and insecticides to augment GOM treatment capacity for each campaign. USAID-financed planes, insecticide stocks and related activities will continue to be concentrated in Guelmim (Turbo-Thrushes) and Agadir (DC-7s). The planes and other materials can be moved quickly to other PC's such as Ouarzazate, Tata or Errachidia, or to critical crop zones north of the Atlas mountains if the intensity of locust infestation in these areas should so warrant. Decisions as to where USAID-financed aircraft will be based and deployed will be made by the Central Command Post, Rabat, in consultation with USAID.

3.2 For each campaign the project will provide short term technical assistance and selected commodities to improve the strategic and tactical planning of treatment operations. Technical assistance will include evaluation of the effectiveness of aerial treatment and insecticide. Greenness maps will be provided and jointly studied by USAID and the GOM in order to more accurately predict the magnitude of infestations expected in North-Western Mauritania and in the Southern Sahara and to refine the aerial spray strategy. Pilot and mechanic training for Turbo-Thrush aircraft will also be provided.

3.3 The project will provide short term technical assistance, training and selected commodities designed to improve insecticide handling, communication capacity, and prospection and survey methods. Selected studies for determining efficacy of alternative insecticides, and calibration of aircraft spray systems will be undertaken.

3.4 The project will assist the GOM to organize environmental, health and safety considerations into an effective local institutional framework so that they can be dealt with systematically and successfully on a long-term basis. This will be accomplished by the consolidation of an Environmental and Health Safety Unit within the Moroccan campaign organization to oversee the design and implementation of all ongoing program environmental, health and safety activities. This Unit will be assisted by USAID-financed Environmental and

Health and Safety advisor(s), and consultants in specific technical areas on an as-needed basis. The project will also assist this unit through the provision of any research, training and commodity support required to ensure that these critical aspects of campaign operations are properly addressed and successfully carried out.

4. Specific Nature of Activities for Completing Current Campaign thru June 1989

4.1 Project activities for the FY 1989 campaign period have been recently assessed in view of the magnitude of the current locust problem. The assessment calls for maintaining two Turbo-Thrush aircraft from January through June 1989. Two large aircraft (DC-7s) will be procured for March through June 1989. They will be based in Agadir (large planes) and in Guelmim (small planes). As swarms are expected to increase dramatically in March-June 1989, following egg-laying and hatching in northwestern Mauritania, and in other regions outside Morocco, there may be a need to procure two additional large aircraft and/or two Turbo-Thrushes from March 15, 1989 through June 30, 1989. This need will be determined by February 1989. 400,000 liters of insecticide will also be procured for prepositioning by March 1989.

4.2 All critical support commodities such as radios, greenness maps, insecticide transfer equipment and any other logistical items will be procured immediately in order to augment overall operational efficiency prior to March 1989.

4.3 An environmental program will be in place by March 1989. Associated environmental, health and safety commodities such as cholinesterase kits, protective clothing and fire equipment will be procured immediately.

4.4 Selected short term technical assistance and training for insecticide handling, insecticide efficacy testing, calibration testing, survey team training and other planned activities will be scheduled between February and September 1989.

5. Projected Activities for Subsequent Campaigns (October 1989 - June 1990 and October 1990 - June 1991)

5.1 Prior to each campaign, an assessment will be undertaken by the GOM and USAID to determine specific nature and level of assistance needed.

5.2 Activities will be of the same type as described in Section 3.0 above. The actual level of assistance will be determined based on assessment (5.1 above), however, it is anticipated that between 6 and 8 million dollars will be required for each of the two subsequent campaigns (see Illustrative Budget for October 1989 - June 1990 campaign).

IV. FINANCIAL PLAN

Input costs are estimated for: (1) the current campaign (i.e., to finish both current and planned activities through June 1989); (2) the second campaign (October 1989 - June 1990); and (3) Future Funding Requirements. Essentially all obligated funds under the initial ProAg (i.e., 3.5 million dollars) have either been committed or expended. Estimated costs of elements necessary to continue the current campaign through June 1989 and to initiate activities for the second campaign will require an approximate $ 10 million obligation immediately. Approximately $6 million will be committed for the current campaign through June, 1989.

Project needs can only be predicted with reasonable accuracy for the current campaign (January through June 1989). Estimated costs for the October 1989 - June 1990 campaign are illustrative. An assessment will be performed between June and August of 1989 to refine the estimated inputs and costs prior to commitment of funds for the October 1989 - June 1990 period. Adjustments in the use of funds within line items is therefore anticipated for successive campaigns.

Given the difficulty of predicting specific funding needs, funds remaining out of the proposed $23.5 million LOP budget after programming approximately $14.0 million for control activities through June 1990 are identified in the financial plan as "Anticipated Obligations". These funds will be applied as described in point 4 below.

TABLE 1

ESTIMATED COSTS FOR INPUTS

1. To complete January, 1989 to June 30, 1989 campaign and prepare for the subsequer campaign.

ELEMENT	COST (dollars)	
Aircraft		
a. Two Turbo-Thrush aircraft through June (600 hours)	500,000	
b. Two DC-7 aircraft from March through June (960 hours)	2,400,000	
c. Aircraft Contract/Logistical Specialist (10 PM)	60,000	
SUBTOTAL		2,960,000
Insecticide		
a. 400,000 liters of Malathion, Bendiocarb or Dursban	1,500,000	
b. Sea Freight	200,000	
SUBTOTAL		1,700,000
Environment, Health and Safety Commodities		
a. Cholinesterase Kits (20)	25,000	
b. Protective Clothing (2000)	220,000	
c. Fire Equipment	30,000	
d. Monitoring Equipment	10,000	
e. Other	40,000	
Logistic Commodities		
a. Drum Disposal	30,000	
b. VHF Radios (12)	22,000	
c. HF Radios (10)	100,000	
d. Drybreak Systems (20)	60,000	
e. Greenness Maps	100,000	
f. Tank Trailers	100,000	
g. Other	60,000	
SUBTOTAL		797,000

Training and Technical Assistance

-	Operations and Improvement Assistance				
a.	Evaluation of Aircraft (DC-7 and Turbo) Application	(1 PM)	12,500		
b.	Pilot and Mechanic Training	(15 PM)	300,000		
c.	Radio Communication Training	(2 PM)	25,000		
d.	Prospection and Survey Training	(2 PM)	25,000		
e.	Helicopter Spray System Re-design	(2 PM)	25,000		
-	Environmental, Health and Safety Assistance				
a.	Environmental Monitoring and Assesment	(12 PM)	125,000		
b.	Evaluation of Large Aircraft (DC-7) Environmental Impact	(1 PM)	12,500		
c.	Insecticide Management Training	(1 PM)	12,500		
d.	Insecticide Testing and Secreening	(2 PM)	25,000		
e.	Cholinesterase Health Specialist	(1 PM)	12,500		
-	Project Assessment, Campaign Assessment and Strategy	(6 PM)	75,000		
	SUBTOTAL			650,000	
Contingencies				250,000	
	TOTAL THROUGH SEPTEMBER 1989				6,357,00

2. October 1989 - June 1990 Campaign (Illustrative)

Aircraft

a.	Two Turbo-Thrush	500,000
b.	Two DC-7	3,000,000
c.	Aircraft Contract/Logistical Special	60,000
Insecticide (800,000 liters)		3,400,000
Environmental, Health and Safety Commodities		200 000

Logistic Commodities	200,000	
Training and Technical Assistance	700,000	
Project Coordination		
Contingencies	250,000	
TOTAL FOR CAMPAIGN		8,360,
3. Audit		100,
4. Anticipated Obligations		5,183,

Possible uses of the funds would be to augment capabilities during the campaigns described above by (1) providing two additional Turbo-Thrush aircraft during January-June 1989 campaign, estimated at $400,000 and/or two additional DC-7s estimated at $2,400,000; (2) providing two additional DC-7's during October 1989-June 1990 campaign, estimated at $2,000,000; (3) providing inputs for an October 1990-June 1991 campaign (to be determined); (4) providing aircraft for an international locust control effort (to be determined); and (5) providing additional funding for the project coordinator.

GRAND TOTAL	20,000

V. IMPLEMENTATION AND PROCUREMENT PLANS

A. Implementation Arrangements

The project amendment is designed to augment the capacity of the GOM locust control operation being implemented by the Ministry of Interior, the Ministry of Agriculture's Crop Protection Service, and the Ministry of Health. The implementation structure is summarized in the Project Paper and in Section VI. D, Institutional Analysis Update, of this project amendment. USAID Morocco Agriculture Division will retain responsibility for directing project activities, with the continuing assistance of the project-funded PSC Project Coordinator and the Aircraft Logistics Specialist. USAID will continue to meet with the donor coordinating committee and maintain contact with the PCC. Daily interaction with the PCC as well as with the project field sites and Aircraft Logistics Specialist will be handled by the Project Coordinator.

B. Procurement Plan

Since procurement of commodities and technical assistance forms the substance of this project and the major characteristic of this project is its unpredictability and potential emergency nature, effective procurement planning is critical.

In general, inputs will be procured through competitive procedures, as time permits. To the extent that time does not permit any given procurement action to occur in a competitive fashion, M/SER/OP/OS has approved a class justification for less than full and open competitive procurement under situations of unusual and compelling urgency applicable to this and all other ANE and AFR Bureau locust control activities (Annex K). This class justification is valid until December 6, 1989, and will be used on a case by case basis, when the USAID Morocco Project Officer certifies in writing that a situation of unusual and compelling urgency exists. Until such time as the Mission has its own contracting officer, all procurement requirements for both full and open competition and for other than full and open competition will be referred to AID/W for action.

The following is an analysis and proposed schedule for the major project procurements.

Air Services Contracts

The present contract with Altair for aerial spraying services of two Turbo-Thrushes expires January 24, 1989. This amendment will extend the Altair contract until June, 1989. There may be a need to increase the number of Turbo-Thrushes under contract from March to June 1989 to four aircraft.

The present contract with T and G Aviation for aerial spraying services of two DC-7's expires in January 1989. It is the intention of the Mission to request AID/W to immediately enter into a new contract with T and G, as the sole source of DC-7 services, in March 1989, for additional flying hours of two DC-7's.

Insecticide

400,000 liters of insecticide will be provided for the spring 1989 campaign (March - June 1989). Up to an additional 1,600,000 liters will be procured in four batches over the next two annual campaigns. These procurements will be made by GSA in time to arrive at the beginning of each spraying season. It is intended to procure sufficiently in advance of need to permit ocean shipping. 400,000 liters of Malathion, Bendiocarb or Dursban or other USG-approved insecticides will be purchased in as many as five procurements, illustratively as follows:

Procurement 1

GSA receives PIO/C	January 10, 1989
Solicitation and award	January 15, 1989
Shipment from US	February 1, 1989
Port	Ocean transit 5 weeks
ETA Morocco	March 15, 1989

Procurement 2

GSA receives PIO/C	June 1, 1989
Solicitation and award	July 1, 1989
Shipment from US	August 1, 1989
Port	Ocean transit 5 weeks
ETA Morocco	September 15, 1989

Procurement 3

GSA receives PIO/C	December 15, 1989
Solicitation and award	January 15, 1990
Shipment from US	February 1, 1990
Port	Ocean transit 5 weeks
ETA Morocco	March 15, 1990

Procurement 4

GSA receives PIO/C	June 1, 1990
Solicitation and award	July 1, 1990
Shipment from US	August 1, 1990
Port	Ocean transit 5 weeks
ETA Morocco	September 15, 1990

Procurement 5

GSA receives PIO/C	December 15, 1990
Solicitation and award	January 15, 1991
Shipment from US	February 1, 1991
Port	Ocean transit 5 weeks
ETA Morocco	March 15, 1991

Health Monitoring Equipment

Twenty health monitoring test kits (Cholinesterase Field Test Kits) will be procured with funds authorized by this PP Amendment. The kits are made by only one company, which is located in England. A waiver of source/origin requirements is contained in Annex F hereto. The kits will be procured by AID/W, following the processing of a sole-source justification for noncompetitive procurement by AID/W.

Equipment

Protective Clothing, Fire Equipment, Environmental Monitoring Equipment, VHF Radios, HF Radios, Drum Disposal Equipment, Dry-Break Systems and Tank Trailers will be procured using a Procurement Service Agent (PSA). Immediate equipment requirements under Procurement One (protective clothing and fire equipment) will be purchased using other than full and open competition under the class justification. More specifically, the Mission intends to use the services of the 8A firm, Americain Manufacturies Export Group, which handled related purchases under the original project agreement.

Procurement 1

PSA receives PIO/C	December 30, 1988
Solicitation and award	January 15, 1989
Production Time	February 15, 1989
Port	April 1, 1989
Distribution in Morocco	April 15, 1989

Procurement 2

PSA receives PIO/C	June 15, 1988
Solicitation and award	July 15, 1989
Production Time	August 15, 1989
Port	September 15, 1989
Distribution in Morocco	October 1, 1989

Technical Assistance

The bulk of short-term technical assistance will be provided either under competitive solicitation from for-profit firms or from existing Agency IQCs.

1. Project Coordination Assistance

- The continued services of a Project Coordinator will be contracted directly by the mission on a PSC basis. The Project Coordinator will be responsible for the day-to-day operation and activities of the Locust Control Project. The Coordinator will continue to work within USAID/ Morocco's Food and Agriculture Office in Rabat and will report to the USAID Project Officer. The Coordinator will provide daily liaison between USAID/Morocco, the GOM Central Command Post (PCC) in Rabat and field operations.

- The ongoing Aircraft Logistical Specialist PSC will be extended to coincide with the air services contracts. This person will support the U.S. aircraft spray operation by identifying and communicating daily aircraft operational needs to the GOM ground support crews. The specialist also monitors the aircraft contract on behalf of USAID and ensures all contract obligations are fulfilled.

2. Operations Improvement Assistance

- Evaluation of the DC-7 operation will entail one person month of effort of a spray specialist to assist in developing guidelines for use of large aircraft in locust swarm control activities. Since the need for this technical assistance is immediate upon signing the Project Amendment, it may be necessary to use the class justification for other than full and open competition.

- Aerial Application Training, including Pilot Training, will instruct Moroccan spray plane pilots in the techniques of crop spraying for fixed-wing aircraft. This activity will take approximately fifteen person months.

- Under upgrading radio communications, two person months of technical assistance will be provided to improve the communication network currently used in locust control activities. Activities will focus on integration of all systems and review of possible frequency assignments to locust control activities, including international communications.

- Prospection and Surveillance techniques will use two person months of services for training GOM experts in advanced prospection and surveillance techniques for locust control.

- Helicopter spray system re-design will require two person months of technical assistance to make helicopter spray systems already procured under the project operational under Moroccan conditions, i.e. working at slower speeds in mountainous areas with wind turbulence. This technical assistance will be provided by the manufacturer of the spray systems.

- Greenness Maps will be provided to the GOM for use in forecasting possible entry routes into Morocco. Maps are produced by USGS under an ongoing centrally-financed project; the Mission will continue present buy-in arrangements.

3. Environmental, Health and Safety Assistance

Depending on final GOM/USAID perceived needs, a long-term or several short-term PSCs will be contracted directly by the Mission to provide continuous support to campaign environmental, health and safety requirements. Primary areas of concern include: environmental monitoring and research; training in hazardous materials management, handling, use and disposal; and compliance with campaign health and safety procedures. A total of 12 person-months of effort has been programmed for these services over the life of the amended project. In addition, these services will be augmented on an as-needed basis by the following short-term consultant inputs:

-- Up to 1 person-month of environmental services to assist in developing appropriate guidelines for the monitoring and use of the DC-7 aircraft.

-- Up to 1 person-month of insecticide management training services to assist the GOM in refining the handling and economic use of insecticides.

-- Up to two person-months of insecticide specialist services to support the GOM's Crop Protection Service in designing and implementing insecticide screening and demonstration trials to promote the use of safe and effective products in ongoing campaign operations.

-- Up to one person-month of health specialist services to assist the Ministry of Public Health in the proper use and monitoring of the cholinesterase testing program recently introduced under the original project agreement (to be procured under the contract for the procurement of the twenty additional test kits).

Additional areas of potential services include a research entomologist to assist in the design, implementation oversight and/or evaluation of the environmental monitoring and research program and a pesticide regulatory expert to assist the Interministerial Pesticide Commission in satisfactorily completing proper guidelines for the registration, handling and use of campaign insecticides. The final "mix" of these total 17 person-months of services will depend upon final program perceived needs, as determined through USAID and GOM consultation, and the particular qualifications and capabilities of the various identified consultants.

4. Project Assessment and Campaign Evaluation Assistance

- Project Assessment and Campaign Evaluation TA will assist the Project to formulate strategies with the GOM for the Fall 1989 to Spring 1990 campaign. This activity is estimated to require six person months of effort.

Implementation and Procurement Schedule

The following is an illustrative implementation schedule, based upon the information currently available.

DATE	ACTIVITY
January 6, 1989	Project Amendment Authorized
January 10, 1989	Project Agreement Amendment Signed
January 14, 1989	Mission cables AID/W to begin procuring commodities.
March, 1989	First Commodities arrive
March - June, 1989	Locust Control Campaign
July - August, 1989	Technical Assistance Training
September, 1989	Commodities arrive
October, 1989 - June, 1990	Probable Locust Control Campaign
October, 1990 - June, 1991	Probable Campaign
June, 1991	PACD and final Evaluation

Methods of Implementation and Financing:

METHOD of IMPLEMENTATION	METHOD of FINANCING	APPROXIMATE AMOUNT
1. Aircraft Direct Contract	Direct Pay	7,113,450
2. Insecticide Direct Contract	Direct Pay	6,548,932
3. Support Commodities Proc. AGT. Contracts	Direct L/COMM	1,374,500
4. Contingency	--	6,573,118
5. Spray Systems Direct Contract	Direct Pay	312,500

6. Training and Technical Assistance		
PSC	Direct Pay	95,000
IQC	Direct Pay	1,382,500
7. Audit		
Direct Contract	Direct Pay	100,000
Total Project		$23,500,000

Gray Amendment:

Although funds to be authorized under this PP Amendment come from the ESF appropriation and, thus, are not subject to the Gray Amendment, the Mission will make best efforts to procure from Gray Amendment entities wherever possible. Specifically, it is planned that the Mission enter into a PSA arrangement with a Gray Amendment firm.

VI. MONITORING AND EVALUATION PLAN

As stated in the Project Paper and confirmed in the Technical Analysis of this Project Paper Amendment, it is not possible to predict accurately the behavior of desert locusts. The project must therefore retain a flexible design which permits periodic revisions as information about future invasion becomes available. Hence, monitoring and evaluation remain critical functions.

A. Monitoring and Assessment

Assessments will be conducted following each campaign to review the performance of GOM locust control operations financed with USAID assistance, identify lessons learned for the next campaign, and, if need be, adjust the assistance package proposed in this Project Paper Amendment. The first critical assessment of campaign activities will take place in late Summer 1989, when information about locusts behavior in other African countries should be available to update projections regarding the magnitude of the October 1989 - June 1990 invasions. At that point, USAID together with the GOM can determine with more accuracy whether the campaign package proposed in this Project Paper Amendment is adequate. The effectiveness of treatment operations will also be jointly reviewed, based on accumulated information provided by AID-financed technical advisors and GOM data. USAID with technical assistance will prepare a campaign assessment report to summarize key conclusions and, if necessary, to adjust future campaign activities. Similar campaign assessments will be conducted during the same time of the year before each of the subsequent campaigns. More informal reviews of campaign activities will occur during the lull in campaign activities between late December and early March.

Monitoring of project activities will be conducted on a weekly basis by the USAID Project Officer. The PSC Project Coordinator will be responsible for briefing the Mission on progress being made in campaigns and for writing monthly progress reports on the status of project and campaign interactions and results.

B. Evaluation

Following the last campaign financed under this Project Paper Amendment, an end of project evaluation will be conducted to determine the efficacy of project activities toward staving off the locust disaster and to derive lessons learned that can be useful to A.I.D. in the design of future projects of a similar emergency nature.

VII. SUMMARY OF ANALYSES

A. Summary Economic Analysis

Morocco's Agriculture accounts for 15 to 20 percent of GDP and employs well over one-third of Morocco's population. Another twenty percent of the population live in rural areas and depend indirectly on agriculture. Over half of Morocco's population are thus exposed to a serious threat from the current locust invasion. Given the importance of agriculture in Morocco's economy, all Moroccans are, in a very real sense, indirectly threatened by the locust plague.

The threat is not a new one. During the last major locust invasion in 1954/55, over ten percent of Morocco's farm land was affected, particularly in the South and in the Souss valley. Assuming that these hectares produce no crop in the years affected, an invasion of similar proportions would destroy agricultural output of one to two billion Dirhams (125 to 250 million Dollars) at today's market prices. Effective protection against such a locust plague has thus potentially significant economic benefits.

By feeding on plants and crops, locusts cause considerable economic damage. By killing locusts, some of that damage may be avoided. Specifically, the economic benefit of killing an individual locust is the avoided crop damage that this locust would have caused over the remainder of its life, plus the avoided potential damage that any possible offspring that this locust might yet conceive would cause.

This damage is, first and foremost, a function of where the locusts are feeding. For purposes of this analysis, a number of zones with varying probabilities of locust infestation have been identified. Zone 1 consists of the area south of the Anti- Atlas, essentially the provinces of Guelmin, Ouarzazate, Errachidia, and Tata. Zone 2 comprises the Souss Valley, i.e. the provinces of Agadir, Taroudant, and Tiznit. Zone 3 is the semi-arid region north of the High Atlas, however, given the low probability that desert locust would penetrate that far north, it is not explicitly considered in the quantitative analysis. It must be kept in mind, however, that if it is not possible to effectively control locusts in zones 1 and 2, zone 3 may also become seriously threatened.

Locusts feed on vegetative matter. It is assumed that the probability that they will attack a particular crop is proportional to the area that this crop takes up in the overall area covered by green plants. For example, the total geographic area of Tiznit province is about 696,000 hectares of which approximately 484,700 ha (70 percent) can be assumed to be covered by some plant growth. Of this total vegetated area 18 percent (86,900 ha) is in cereals. It is therefore assumed that the probability of a specific locust swarm in Tiznit province landing and feeding on a cereals field is 18 percent. At this level of probability, it takes only about 20 swarms to virtually assure (99 percent) that at least some cereals fields will be affected.

At different times of the year, locusts cause different amounts of damage to crops. Thus a locust infestation in a cereals field in March or April will cause much more damage than in November or December. Citrus crops are most vulnerable during the flowering season (February through March). As a result, the economic danger posed by locusts to crops in the two most exposed zones varies by time of year. It must be kept in mind, however, that these sorts of considerations are based on likely damage, not possible damage. It is possible that a very large and dense gregarious swarm of locusts can completely destroy an orchard at any time of the year. It is also possible that a swarm causes much less damage than what we assume.

Finally, one must take into account the likely migration patterns of locust. By analyzing the direction and speed of typical locust migrations in the south of Morocco, it is possible to predict, albeit with a great degree of uncertainty, which areas will be affected and the damage that will be caused. Comparing this to the cost of eliminating or neutralizing locust swarms, is the basis of the economic benefit-cost analysis.

The detailed calculations are presented in the economic analysis in the Annex. The expected damage of one ton of locust (1/2 hectare at an average density of about 100 insects/ha) in a swarm located in the southern part of zone 1, and migrating on a trajectory north with a good chance of reaching the Souss valley, varies from about 100 to 400 DH/ton (200 to 800 DH/ha) over most of the locust season (October through June). A similar swarm in the foothills of the Anti-Atlas or even on top of the mountains poses a significantly higher threat, while a swarm farther south or on a different migration path, poses a lower threat. By experience, costs of spraying operations are around 24 Dollars per hectare (200 DH/ha) treated. If treatment is effective and the swarm is one hundred percent neutralized, which requires a kill efficiency of around 70 to 80 percent, the costs of neutralizing one ton of locusts are approximately 100 DH. These estimates, arrived at under fairly conservative assumptions, imply a benefit-cost ratio of between one and four to one, justifying the expense of eliminating the locust, provided the control efforts are carried out with a high degree of efficiency.

The efficiency of locust campaigns depends on strategy, tactics and technique. Several USAID-sponsored observers of the Moroccan anti-locust campaigns have noted that overall the Moroccan locust teams are technically good to excellent. Blocks are marked adequately, spray planes fly at the proper height, swath width is good, dosage of insecticide is sufficiently controlled, etc. Some additional improvements are possible and are planned under this project through the provision of better ground to air communication to allow spotters and pilots to maintain radio contact, and through better training of ground crews and pilots.

Similarly, the overall strategy, to protect the valuable crop land first, is appropriate. The coordination of the strategy from the PCC in Rabat, and the necessary logistic support to pre-position equipment and expendables, is carried out well. USAID will maintain the dialogue on strategic issues with the GOM and assist wherever USAID assistance can be used. One example of that assistance is the provision of greenness maps, which are used regularly by the GOM for its strategic decisions.

The area where most improvements can be made is the tactical planning of the day-to-day operations. Where spray operations have yielded poor results, it has almost always been due to tactical errors such as spraying too late in the day, spraying when climactic conditions are unfavorable, treating swarms that pose little threat because they are not on a path to valuable crop land or because they have already been sprayed before. Another tactical error is failure to maintain adequate reserves (i.e. keeping some airplanes on the ground) to use against targets of opportunity or completing missions that other planes failed to complete.

The most frequent of these errors is spraying of swarms too late in the day or under adverse weather conditions (e.g. too cold). Under these conditions only a small fraction of the insecticide reaches its target and mortality is accordingly reduced. According to a report by a technical assistant who carried out the only actual tests of mortality in swarms sprayed in the late morning, found that mortality after 24 hours was only about 12 percent, despite generally good to excellent spray technique (adequate height of flight path, properly marked block, etc.). At this mortality rate, the cost per ton of locusts neutralized was over 800 DH (1600 DH/ha) and, unless the swarm was virtually in the process of entering the Souss valley, was almost certainly higher than the damage this swarm was likely to cause. For all intents and purposes, the flight time and the insecticide were wasted. It might have been better to wait until the conditions for spraying improved, so that a higher efficiency could be obtained (reducing cost), or until the threat posed by the swarm was better known (increasing benefits).

Fortunately, it does not seem that such errors are frequent enough to call into question the overall economic viability of the project. Nevertheless, care should be taken to minimize the waste of resources due to tactical mistakes. The project will provide training and technical assistance to reinforce the tactical capacity of the regional PCs from where USAID provided aircraft will operate. The technical assistant, in cooperation with the Moroccan commanders directing the locust campaigns, will seek to maintain adequate target evaluation and selection, assist in elaborating tactical options, and monitor the efficiency of individual spray missions to develop more information for tactical decisions. Even small improvements in tactics can have significant results on the benefit-cost ratio of the project. If, as part of this cooperation, the overall efficiency of the Moroccan locust campaigns can be improved, benefits will be that much higher.

Finally, some experts believe that if sufficient locusts can be eliminated, and environmental conditions become somewhat less favorable to the locust, the locust plague might be broken and not recur again next year. However, given that irrespective of any Moroccan efforts, locust populations in the Sahel will be replenished from locust populations in northern Mauritania and southern Algeria, as well as from the large swarms that escaped treatment in the Red Sea area. The chances of such a fortunate outcome materializing seem, unfortunately, rather slim. Unless a substantial reduction in the entire population returning to the Sahel, not only the locusts coming from Morocco, is achieved, the size of next years population will essentially be unaffected. Under these conditions, where a significant

number of gregarious locusts will reach the Sahel anyway, the size of next year's locust population migrating into Morocco will be almost exclusively a function of breeding conditions in the Sahel which in turn depend on the weather.

Even if successful, it must be kept in mind, that the elimination of the locust would hardly be permanent. At best, the benefits of breaking the plague would amount to avoided control costs in future years plus any damage that might occur despite control efforts. Given the great uncertainty associated with this scenario, it does not, by itself, represent a sufficient justification for the anticipated control efforts.

Nevertheless, the potential benefits should not be forgotten. They are in the nature of externalities or additional benefits, that will make the project that much more profitable if they are realized. If they fail to materialize, (i.e. if the GOM is unable to break the plague), the project, focusing on crop protection, is nevertheless amply justified, provided control efforts are carried out with an adequate degree of efficiency.

B. Summary Environmental Analysis

An environmental assessment of the original Locust Control Project was duly completed in April 1988 in accordance with the Agency's 22 CFR 216 environmental procedures. This document properly addressed all salient Agency concerns regarding the environmental aspects of this project to the extent feasible given the information and experience available on this subject at that point in time. However, much has happened since the completion of this original EA, and new information and insight has been gained regarding the current status of existing local control program operations and procedures and the most appropriate mechanisms for ensuring that Agency environmental concerns are being properly addressed.

Based upon this additional information, the Update examines the status of project activities within five general categories of locust control campaign operations. These include:

- Insecticide Selection

- Efficacy of Selected Insecticides for Locust Control

- Application Methods and Equipment

- Ability of the Government of Morocco to Regulate or Control the Distribution, Storage, Use and Disposal of Insecticides

- Effect of Selected Insecticides on Non-Target Organisms and the Natural Environment

Each of these five topics is addressed in relation to the original EA findings and recommendations, new information or experience which has been gained since the original EA completion, and a list of specific recommendations to be followed for all future AID-assisted control program operations. The bulk of the new information and resultant recommendations were obtained through the work of the two AID-financed, short-term consultants (Entomologist/Environmental Monitoring Specialist and Insecticide Management and Health/Safety Specialist) recommended in the original EA. Whereas the Update generally confirms the original EA results, it also provides greater specificity and definition to ongoing program environmental requirements as a result of the additional Morocco-specific information now available on this subject. In addition, the Update provides recommendations for certain longer-term institutional improvements in campaign environmental, health and safety operations in recognition of the possibility that the locust plague may continue for several more years to come.

The overall thrust of the Update recommendations is that control program environmental, health and safety considerations need to be organized into a suitable local institutional framework so that they can be dealt with systematically and effectively on a long-term basis. Past experience clearly shows that the myriad of such important considerations cannot be successfully dealt with on a short-term, "ad-hoc" basis, especially during actual campaign operations. Thus, the recommendations fundamentally call for the consolidation of an Environmental/Health Safety Unit within the Morocca.. campaign institutional framework to oversee the successful design and implementation of all ongoing program environmental, health and safety considerations. This Unit would be assisted by USAID-financed Environmental and Health Safety advisor(s) for the duration of USG assistance to the program, and short-term consultants in specific technical areas on an as-needed basis. The Unit would have primary responsibility for all aspects of program environmental and health safety considerations, including: the design and scheduling of appropriate technical assistance, training, research and monitoring activities; specification of the types and amounts of program environmental and health safety commodities requirements; completion of all required insecticide health, safety and regulatory information, brochures and procedures; monitoring the status of implementation of program environmental and health safety recommendations; and preparation of periodic, comprehensive campaign reports covering all environmental and health safety aspects of ongoing campaign operations.

Certain other Update recommendations relate to program operational areas, such as pilot and ground crew training for improved aerial spraying effectiveness and insecticide efficacy demonstrations to promote the most cost-effective, safe and appropriate application techniques for Moroccan conditions. It is believed that most of these latter recommendations can be dealt with adequately through the provision of short-term training assistance and a relatively modest purchase of commodities for improved target area survey, delimitation and ground to air communications.

While all of the above recommendations are important, priority attention should be devoted to the successful implementation of the myriad of program

training and educational requirements indicated throughout the Update. This objective will require the coordinated assistance of specialized, short-term experts in the areas of: aerial agricultural spraying techniques; locust ground survey and target delimitation techniques for aerial operations; terrestrial treatment application techniques and safety precautions; hazardous chemicals handling, use and disposal procedures; health and medical considerations for hazardous chemicals use; and, pesticide regulatory and information procedures development. This latter assistance category will provide the bulk of the information required to implement an expanded public education and awareness promotion program to ensure that local populations are properly informed regarding locust movements and spraying operations, and necessary health and safety precautions.

In conclusion, the Update largely reconfirms the original EA findings for continued USAID involvement in Moroccan locust control operations. Moroccan campaign personnel generally seem to have a good appreciation of the potential environmental hazards associated with this type of activity. Serious problems do exist, however, in certain program areas, most notably in aerial application targeting and efficacy and the myriad of procedures being employed in insecticide handling and use. Update recommendations provide for addressing these problems through a comprehensive and systematic program of research, technical assistance, training and commodity support, as well as establishment of a campaign-wide environmental monitoring program. If these recommendations are properly carried out, it is believed that the program can be implemented in an environmentally acceptable manner commensurate with all salient Agency regulations.

C. Summary Technical Analysis

Although the magnitude of locust invasions into Morocco may vary (i.e., 10 times larger during the current campaign than during the first campaign (October 1987 - June 1988), the pattern of invasion for each campaign is similar, providing a basis for developing and implementing control strategies. Moreover, the unique nature of these predictable patterns of invasion in Morocco provides an opportunity for applying a strategy that not only protects Moroccan agriculture but also may reduce the overall global locust population returning to summer breeding zones in the Sahel.

The principal objective of the GOM strategy has been and continues to be protection of crops in major agriculture regions such as the Souss valley and areas north of the Atlas mountains. However, the GOM is acutely aware of the regional migratory nature of the desert locust and the potential impact of an uncontrolled plague on all affected countries. Given the fact that a major portion of the total desert locust population migrates into Morocco between October and June, and concentrates in the region south of the Atlas, the GOM is also committed to a strategy of reducing the overall population (breaking the plague) which would otherwise return to the Sahelian summer breeding regions.

The strategy consists of treating locusts behind (south) of the Atlas and Anti-Atlas mountains where they invade and concentrate. The Atlas mountains provide an effective barrier and permit treatment to take place in the most

unproductive (economically) and lowest populated (human and livestock) areas of Morocco. This region also permits the GOM to develop and implement a realistic treatment strategy taking into account tactical considerations. For example, invading swarms normally spend several days to several weeks in this region, depending on climatic factors, before they reach the Atlas mountains. This allows sufficient time for prospection and treatment. Once swarms reach the mountains, prospection and treatment becomes much more difficult because of terrain. Moreover, if the concentrating effect of swarms is allowed to continue as they move northerly toward the Souss valley, it then becomes necessary to deploy greater numbers of aircraft in more highly populated areas and in a shorter treatment time frame.

Thus far, the current strategy has blocked locust swarms from crossing the Atlas mountains (except for several minor swarms in the Fall of 1988) and entering into important crop production areas. Nevertheless, the GOM and USAID have begun to consider how the strategy would need to be altered if, in fact, major migration across the Atlas occurred. The GOM has already begun to equip five new PCs (Marrakech, Kenifra, Safi, Essaouira and Missour) for possible activation should the need arise. These PCs are linked to the central PCC institutional structure, have limited insecticides stocks (5,000 - 10,000 liters), one small aircraft at their disposal, and a variety of ground base spray equipment. If the situation warrants, the GOM will augment resources (aircraft, insecticides and logistics) at these PCs. Additional PCs also would be developed as needed.

It is not possible at this time to predict where and how many swarms might penetrate into regions north of the Atlas mountains. The GOM would give highest priority to protecting the Souss valley and other irrigated areas such as Beni Mellal. Treatment would consist of both aerial and ground based spray operations. It is likely that greater involvement by farmers themselves can be anticipated, utilizing backpack sprayers. Alternative insecticides, such as Decis or possibly bran baited insecticide, would be employed. USAID and the GOM will further assess the preferred strategy for possible intervention north of the Atlas mountains and determine what, if anything, the project would provide to augment existing local capacities.

The current GOM strategy is to increase its overall aerial treatment capability to 100,000 hectares per day. Currently, the capacity is about 83,000 hectares per day, but varies depending on availability of both GOM and donor provided aircraft. As of December 15, 1988, the capacity consists of about 23,000 hectares capacity provided by GOM aircraft (one C-130 and 11 small aircraft). In addition, the GOM currently has 21 small aircraft on lease providing about 20,000 hectares per day capacity. There are approximately 14 donor aircraft providing about 37,000 hectares per day. Of the latter, USAID is supplying about 25,000 hectare per day capacity with two Turbo-Thrush and two DC-7's. Unfortunately, the aerial treatment capacity is extremely fluid as the GOM cannot rely on most donors for long term commitment (except USAID) nor has the GOM been able to lease aircraft with certainty. For example, 15 Turbo-Thrush aircraft currently under lease, will not be available after March 1989.

The GOM has significantly expanded its arerial survey, prospection and marking capability since the first campaign. Some training and improved logistical capability has been given to these teams. However, there are several areas which still need to be improved. One difficulty relates to the problem of tracking flying swarms. Survey teams attempt to follow swarms until they settle. However, this is not always possible because of terrain or the inability to keep up with the swarms by vehicle. Thus, lost swarms are often sighted again and recounted, leading to over-estimation of the number of swarms. It is also difficult to estimate accurately the size of flying swarms. Survey is more difficult in mountainous regions where vehicles cannot penetrate. Survey capabilities will be enhanced by providing additional portable radios to all survey crews and by training them in how to utilize them. In addition, training to improve survey and prospection techniques, marking swarms for treatment, and standardized information reporting (resting swarms) will increase the accuracy of overall target selection and treatment. Additional helicopter prospection may also be useful in order to track major swarms. The project will provide selected commodities, technical assistance and training of trainers in order to improve the survey capability.

For purposes of planning and overall readiness, the GOM attempts to maintain a two million liter stock of prepositioned insecticides at least three months in advance of anticipated invasion periods. With ULV application, this quantity would treat approximately two million hectares. This quantity could be utilized fairly rapidly during peak invasion periods. For example, the GOM is attempting to achieve a control capacity of 100,000 hectares per day. A sustained treatment capacity at this level, on a daily basis would require nearly 100,000 liters of insecticide per day. The stock supply would be consumed in 20 days. As stocks are depleted, the GOM attempts to replenish the 2 million liter stock supply in order to keep a reserve on hand. Obviously, this becomes difficult during peak invasion periods because the consumption rate is high. Insecticides are furnished by donors and by the GOM with the bulk now being purchased with GOM resources. USAID believes this prepositioning strategy is sound and will assist the GOM with procurement of selected insecticides for prepositioning purpose (normally 400,000 to 800,000 liters per campaign).

USAID will not utilize non-U.S. Government-approved insecticides, such as DDPV. Moreover, USAID will strongly discourage the GOM from using such insecticides. The GOM has indicated its willingness to restrict DDVP use to the more remote treatment regions, and also its interest in knowing more about U.S. findings and restrictions on its use.

A number of recommendations are given in the Environmental Analyses (Annex C), relative to efficacy testing of alternative insecticides, improving insecticide handling, storage and disposal systems, and increasing treatment efficiency. These recommendations will be implemented under the project. USAID will provide technical assistance, selected commodities and training in support of these objectives.

D. Institutional Analysis Update

The magnitude of the locust invasion into Morocco during the Spring and Fall 1988 prompted the GOM to add seven Regional Command Posts (PCs) to the five original posts. Four of the new PCs became operational during Summer 1988 at Guelmin, Tata, Laayoune, and Dakhla. The Guelmin and Tata areas have experienced some of the heaviest infestations, with 435,321 and 238,269 hectares treated, respectively, between October 10 and December 5, 1988. The intensity of infestation in these areas is due to their favorable locust habitat created by the mountain barrier and proximity to river beds which provide necessary moisture levels. The Guelmin PC is currently the most heavily equipped post, including access to a military landing strip capable of supporting large aircraft such as the Moroccan C-130s and USAID-funded DC-7s as well as the USAID-funded Turbo-Thrush.

Five additional PCs were added in November 1988, following the overwhelming invasion in late October which brought locusts into the high-value agricultural areas of the Souss and Massa valley and the wheat basin between Settat, Chichaoua and Safi. The Missour PC is aimed at infestations arriving from Algeria, while the Khenifra and Marrakech PCs are poised to control invasions across the High Atlas Mountains. The Essaouira and Safi PCs were installed to control invasions through the coastal areas which lie outside the natural barrier of the Atlas Mountains.

To enhance the accuracy and flexibility of operations, the Regional PCs are complemented by 36 Subcommand Posts (Sub-PCs) which maintain stocks of insecticide and aircraft fuel. The Sub-PCs conduct prospection and surveillance in their areas and communicate the information to the regional PCs. The Sub-PCs are, in turn, supported by 106 operational units serving as a front line of defense and early warning system.

As described in the Institutional Analysis of the original PP (Section VI. D.), the Gendarmerie Royale, which has overall responsibility for the implementation of the locust control strategy, works in close collaboration with the Ministry of Interior, the Ministry of Agriculture's Crop Protection Service, and the Ministry of Health. To ensure coordination with the donor community, the Central Command Post of the Gendarmerie in Rabat (PCC) holds weekly donor coordination meetings. The meetings are attended by representatives of fourteen donor countries in addition to USAID, the FAO and the EEC. The PPC provides written updates on areas treated, equipment and logistical status, and projections of anticipated treatment. In addition, a daily situation report is furnished to donors and other affected countries in the region.

The GOM has strengthened its field operations both in terms of equipment and personnel. An additional 200 agricultural technicians have been trained during Summer 1988 to enhance the mid-level management of operations. Efforts have been made to maximize on-the-job experience and ensure smoothness of operations by maintaining the continuity of non-technical staff. Since the Spring 1988 Campaign, the international donor community, including USAID, has donated additional protective clothing and communications equipment. However,

available equipment and expertise continue to fall short of the need, particularly given the increased magnitude of operations anticipated in the future. There is a need to enhance the capacity of the communication network to handle a growing volume of communications requirements associated with the expanded size of operations. Current methods of insecticide handling and aerial application must be upgraded. Finally, the environmental impact of locust control activities must be monitored in a more systematic and comprehensive manner.

VIII. SPECIAL COVENANTS

A. Pesticides

The Grantee agrees to utilize only AID-approved pesticides in AID-financed aircraft and equipment and to follow recommended procedures for spray operations for each pesticide purchased under the Project as agreed upon by the Parties.

B. Pesticide Drum Disposal

The Grantee agrees to destroy, or otherwise render useless, and dispose of in an environmentally sound manner, empty containers of A.I.D.-financed pesticides, for health and safety considerations.

C. Geographical Limits of Aerial Spraying Operations

The Grantee will ensure that all U.S.-financed aircraft treat only within geographic areas defined jointly by Grantee and USAID.

D. Navigational Maps and Briefings

The Grantee will provide adequate navigational maps to all AID-financed pilots. Before each treatment, a briefing concerning all flying conditions will be held with the pilots of A.I.D. financed aircraft.

E. Redeployment of Aircraft

The Grantee will obtain the agreement of the AID/Morocco Mission Director, in writing, prior to redeploying AID-financed aircraft from Agadir (in the case of the DC-7 aircraft) or Guelmim (in the case of the Turbo-Thrush aircraft).

ANNEX A

LOGICAL FRAMEWORK

LOGICAL FRAMEWORK

PROJECT TITLE AND NUMBER: MOROCCO LOCUST CONTROL - PROJECT 608-0196

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal:	Measures of Goal Achievement:		
To protect Moroccan crops and livestock from the locust plague in ways consistent with protecting the health and well-being of the people and the environment of Morocco.	Major agricultural and livestock production areas are protected from locust invasions.	1. GOM information surveys and USAID monitoring of crop and livestock production in major regious such as Souss Valley and cereals regions. 2. Timely and accurate reporting of information from other countries. 3. Periodic campaign environmental and health reports.	1. Regional Maghrebian control efforts are effective. 2. Regional sahelian control efforts are effective. 3. Individual country control efforts are effective. 4. Climatic conditions in Sahel do not remain favorable for population build-up over long term.
Project Purpose:	End of Project:		
To assist the GOM in coordination with other donors to control desert locusts from January 1988 through June 1991.	Locust population in Morocco are reduced or maintained at non-threatening levels (reduced from gregarious to solitary life cycle).	1. GOM and USAID field assessment of locust populations in Morocco. 2. USAID monitoring using GOM computerized information network.	1. Locust invasions from neighbouring countries do not become overwhelming. 2. GOM provides timely and accurate assessment of locust populations. 3. GOM is able to provide timely inputs (fuel, coordinations and logistical support) for control operations.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Purpose:	**End of Project:**		
1. Enhanced capacity to control desert locusts through aerial spraying of insecticides.	1. Capability to treat from 2,000 to 50,000 hectares per day, depending on need and utilizing turbo thrush and DC-7 aircraft.	1. PCC reports, airplane monitoring, briefings and feedback from technical assistance.	1. Aircraft availability. GOM is able to manage and coordinate increased number and size of aircraft.
2. Improved Strategic planning and tactics of control operations, including preparation for appropriate response north of the Atlas mountains, if necessary.	2. Improved GOM ability to prepoai-tion pesticides and aircraft in a timely manner, better targeting of control methods, and improved selection of control tactics.	2. PCC reports, Project Officer monitoring, special studies of trends in efficiency of treatment.	2. GOM is willing to take advice from foreign advisor financed by the project. Sufficient information gathering and analytic capacity is possible to install, given short time frame.
3. Improved efficiency of operations such as survey, treatment and communications.	3. Training of Trainers for training of pilots; pesticide handlers; ground survey teams; and radio/communication operators - logistical support for all operations in place and working.	3. Project Officer monitoring. Briefings from technical advisors and assessments after each campaign.	3. GOM can effectively absorb technical and managerial advice provided under the project.
4. Improved GOM capacity for the management and monitoring of environmental safety and health aspects of campaign operations.	4. GOM environmental unit in place and providing effective guidance to PCs. T.A. helping GOM unit with environmental program.	4. Evaluation from technical assistance. Mission Environmental Officer does periodic follow-up visits and reviews GOM reports.	4. Size of locust invasion remains "manageable", in the sense that fear or panic do not cause uncontrolled spray operations.

1. AID Contribution

	From Previous LOP 1/	To September 1989	From October 1989 to September 1990	Future to 1991	To LOP
Aircraft	593,450	2,960,000	3,560,000		7,113,450
Insecticide	1,448,932	1,700,000	3,400,000		6,548,932
Miscellaneous Commodities	177,500	797,000	400,000		1,374,500
Contingency	890,118	--	--	To be determined	890,118
Spray Systems	312,500	--	--		312,500
Training and Technical Assistance	77,500	650,000	810,000		1,477,500
Audit	--	--	--		100,000
Future Funding Requirements	--	--	--		5,683,000
TOTAL	3,500,000	6,107,000	8,170,000	5,683,000	23,500,000

1/ All expended as of December 1988.

2. GOM Contributions

The GOM anticipates spending approximately 216 million DH or $26.6 million through December 1988. The GOM contribution for 1989 (Jan-Dec) is projected to be $50.0 million.

ANNEX B

ECONOMIC ANALYSIS

ANNEX B

ECONOMIC ANALYSIS

Morocco's Agriculture accounts for 15 to 20 percent of GDP and employs well over one Third of Morocco's population. Another twenty percent of the population live in rural areas and depend indirectly on agriculture. Over half of Morocco's population are thus exposed to a serious threat from the current locust invasion.

The threat is not a new one. During the last major locust invasion in 1954/55 over ten percent of Morocco's farmland was affected, particularly in the South and in the Souss valley. Assuming that these hectares produce no crop in the years affected, an invasion of similar proportions would destroy agricultural output of one to two Billion Dirhams ($125 to 250 million) at todays market prices. Effective protection against such a locust plague has thus potentially significant economic benefits.

Fortunately, much of Morocco's agriculture enjoys some, albeit limited, natural protection against invasions by locust swarms. The Atlas mountains, especially the High Atlas, have significantly reduced the incidence of locust swarms in the semi arid cereal growing region around Settat and the agriculturally valuable Meknes plain (see D. Pedgly, ed., Desert Locust Forecasting Manual, 1981). Over the past 37 years, locust were reported during the peak month of December 16 times in the Guelemin area, however only three times in Settat and never in Meknes. The corresponding figures for January are 16, 7, and 2. Averaging these monthly observations over the four-months locust season (October through January), the average incidence is approximately 15 around Guelemin, 3 around Settat, and 1 around Meknes.*

The corresponding number for the region of Agadir/Taroudant is twelve. This implies that in the Souss valley, locust swarms have been sighted during almost as many months as around Guelemin. However, it must be kept in mind that more locusts are likely to go unreported in the vast and thinly populated areas south of the Anti-Atlas, than in the densely populated Souss valley. Furthermore those sightings do not account for the size or number of swarms. A single small swarm in a given month will be weighed as heavily as a serious infestation of numerous large swarms during the same month. It is thus likely that the true ratio of the number of locust swarms in the Souss valley to swarms south of the Anti-Atlas is significantly less than 12 to 15. Nevertheless it is clear that the relatively low Anti-Atlas that separates the Souss valley from the South is a much less effective barrier against locust, than the more formidable High Atlas that separates the Souss from the semi-arid zone around Settat.

---

*The incidence of swarms after the Spring breeding season (late March through June) follows roughly the same pattern. However, since at that time of the year locust are more widespread than ever, the differences in number of months where locust were reported in a specific area are less pronounced. Furthermore, the predominant winds are from the North at that time of the year, so that much of Morocco profits from a substantial out-migration of locust.

For the purpose of analyzing the locust threat, one can therefore partition Morocco into a number of distinct zones. Zone 1 is thus represented by the four provinces of Guelmin, Tata, Ouarzazat and Errachidia. These four provinces face the highest locust threat in terms of a likely invasion by swarms. This is due to the fact that no natural barrier separates these provinces from the Sahara, including southern Algeria and northern Mauritania, where locusts can breed and multiply unhindered.

Zone 2 consists of the provinces of Tiznit, Agadir and Taroudant. It is separated from Zone 1 by the Anti-Atlas as well as by some southern ranges of the High Atlas mountains. It faces a smaller threat from locusts than zone 1, as far as the simple probability of locust swarms invading the Zone is concerned, however given the much more intensive agriculture in this area, the potential damage that locusts can cause is much greater.

Zone 3 is the semi-arid region around Settat (provinces of Azilal, Beni Mellal, Ben Slimane, El Jadida, El Kalaa, Essaouira, Khouribga, Marrakech, Safi, and Settat. This zone faces a still smaller threat than zone 2, and the more extensive agriculture practiced there is somewhat less vulnerable. However the sheer size of the zone, almost eight million square kilometers, and the fact that almost one third of Morocco's population live there, make the region nevertheless very important.

Determinants of Locust Populations

A number of factors influence the total number of locusts infesting a particular zone. For most of Morocco the most important is the number of locusts migrating in from the south, particularly the Sahel. To this number one must add the number of locusts hatching in Morocco, from eggs laid by previous populations, and deduct the number killed by control efforts.

In any given geographic area, however, there is a limit on the total number of locusts that can be supported. Absent any control efforts, locust populations will expand until they take up all the available living space. Once that limit is reached, mortality will increase and the population will tend to stabilize until it ultimately begins to decline.

Consider zone 1. There are roughly four to five million hectares of agriculturally used land in that zone, mostly in the form of pasture and rangeland. There must be additional acreage with some plant cover, however it is probably highly variable as a function of rainfall. The total geographic area for the four provinces is 15.6 million hectares. As a first approximation we can therefore safely say that the maximum number of locust that can live in zone one are the number that 4 to 15 million hectares of land can support. Given that much of the zone is desert, it is likely that the true limit is closer to four than to 15 million. As an estimate for the calculations here we assume six million hectares, which at a density of 100 locust per square meter corresponds to roughly six trillion animals which at an average weight of 2.2 grams would weigh fourteen million tons.

Obviously, this limit could never be reached. To begin with, the entire zone probably does not produce sufficient food to support 14 million tons of animals eating their weight in plants each day. If locusts in numbers close

to that limit would invade zone 1, even if they would not all arrive at once but arrive in waves, they would soon die of starvation, cannibalism, or both. A practical limit of the maximum number of animals that can invade zone 1 is probably still much smaller than the 14 million tons cited above.

Another reason why the locust population will never aproach the theoretical upper limit is the scarcity of available breeding grounds. The total area of suitable breeding grounds expands and contracts as a function of rainfall and may easily double or be cut in half from one year to the next. In most years, however, the total number of locust migrating out from the traditional and intermittent breeding zones is significantly less than what is theoretically possible, given natural population growth possibilities and size of the previous generations.

The lower limit for the number of locust in zone 1 is given by the numbers that migrate in from the surrounding areas in the south. Unfortunately, in that region, the supply of locusts appears to be virtually unlimited. For security reasons, large areas in southern Algeria and northern Mauritania are extremely difficult to treat, and even if the cooperation of the disputing parties could be obtained, it is unlikely that more than a small fraction of the swarms and hopperbands infesting these areas could be identified for treatment. For all intents and purposes this area represents a breeding ground for virtually unlimited numbers of locusts. Current estimates are that up to twenty million hectares of locust (40 to 50 million tons) could emanate from this region this year, and as pointed out above, nothing limits the migration if a large number of them into zone 1.

Given this supply, it is probable that without any control effort locust populations in zone 1 could eventually reach the maximum that the zone can support. Even with vigorous control efforts it is not at all certain that any significant or lasting reduction in the population can be achieved. By killing insects in zone 1 we may simply remove competitors for subsequent swarms. In other words, by thinning out the population somewhat, we also improve the chances of survival for the remainder, and the total population may, after a few generations, approach the maximum number possible.

The recognition that availability of parents is rarely the binding constraint to locust populations, leads locust specialists to conclude that for effective population control 98 percent of the locust population needs to be eliminated or at least neutralized. This does not necessarily mean that 98 percent have to be killed. By eliminating a smaller fraction, the GOM may be able to break up the cohesion of the remaing population in swarms and thus cause them to revert to the solitary phase. For example, if the GOM is able to eliminate a sufficiently large number of locusts in Morocco, before they migrate back south into the Sahel, it is possible that the survivors will disburse throughout the Sahel to the point of becoming solitary again. However, this optimistic scenario may still require the elimination of larger numbers of locusts than is technically possible.

Consider zone 2. Total agriculturally used area in this zone is only about 400,000 ha, and the total geographic area is less than three million hectares. Much of the three million hectares is in fact mountains, and covered by snow during most of the locust season. The practical upper limit for the locust population in this area is probably around six to seven hundred thousand hectares, about 1.5 million tons of locusts.

The lower limit is given by those animals migrating from zone 1 into zone 2. Obviously, this number is less than the total number of animals in zone 1. However, given the prevailing winds, the fraction may nevertheless be significant, especially during the winter locust season.

Fortunately, zone 2 is separated from zone 1 by the Anti-Atlas mountains which limit the inflow of locusts somewhat. Especially during the winter and early spring many locusts will die as they are being blown across the mountains. Evidence of this is provided by the lower frequency of observed swarms in zone 2 than in zone 1 during the last 37 years (see above). The number of animals arriving in zone 2 is thus only a fraction, of all the animals in zone 1. This fraction is the product of the proportion of animals blown in the direction of zone 2 and the survival rate of this group. Nevertheless, if left unchecked, the total infestation in zone 2 may still reach the maximum possible.

There is no information available on the average size and density of swarms in zone 1 versus average size and density in zone 2. It is probable that, in the process of being blown across the mountains, swarms are broken up into smaller groups. It is also likely that in the thinner air at high altitudes swarms are less dense than at sea lvel. However, they may concentrate again and re-form as large swarms, once they arrive in the Souss valley. To avoid the difficulties posed by these uncertainties, we measure locusts not in hectares, but in numbers of animals or tons of locust. This figure is readily arrived at by multiplying the estimate of the size of a swarm in hectares by the average density. If no information on the density is available, the average of 100 locusts per m2 can be used. At this density, a hectare of locusts contains about 2 tons of insects.

Consider a hypothetical example. Assume that the population of locusts in zone 1 is 9 million tons, and that one third of them get blown in the direction of the Souss valley by the prevailing winds. Assume also that 70 percent of these insects survive being blown across the mountains and actually arrive in the Souss valley. This would result in 2.1 million tons of insects in the Souss valley (9x1/3x.7=2.1) a number more than large enough to devastate the agriculture of zone 2.

Economic Benefits of Killing Locusts

By feeding on plants and crops, locusts cause considerable economic damage. By killing locusts, some of that damage may be avoided. Specifically, the economic benefit of killing an individual locust is the avoided crop damage that this locust would have caused over the remainder of its life, plus the avoided potential damage that any possible offspring, that this locust might yet conceive, would cause.

One fact is immediately apparent: Killing old locusts that will no longer lay any eggs will avoid considerably less economic damage than killing immature adults that are yet to lay their eggs. Ceteris paribus one should therefore concentrate spraying operations on immature adult swarms of locusts.

It does not seem possible to predict the life expectancy of locust swarms, even approximately. Immature adults tend to migrate until they find suitable breeding areas. Depending on rainfall and wind direction this migration may last up to three to four months, or it may terminate after a few weeks. Cold temperatures may also retard maturation. When suitable breeding areas are found, swarms tend to settle and disburse into smaller breeding groups. After the first egg laying, these groups may re-form into larger swarms and resume migration. The second egg laying may thus take place several hundred kilometers downwind from the first swarm. Under favorable conditions even a third egg laying may take place. Under laboratory conditions locusts have lived for over one year.

Over this life cycle, natural mortality continually reduces the number of individuals in a swarm. Swarms re-forming after the first egg laying are definitely smaller than the corresponding swarms of immature adults. This also reduces the economic damage that an aging swarm of locusts will cause.

As a working hypothesis for this analysis, we assume the following life cycle: By the time they are sighted in southern Morocco, locust swarms are expected to live another 10 to 20 days as immature adults. During that time they are quite voracious, eating up to their own weight each day. We use the shorthand "pink" to characterize all swarms before they have laid their first set of eggs, recognizing full well that as they mature they will actually turn yellow. After maturing, the locusts will lay their first set of eggs. During this time they are dispersed, causing little direct economic damage. After the first egg laying, some of them, probably a little over one half of the original number, would re-form as a new swarm that would migrate for another four to five days before laying the second egg pods. For simplicity we characterize this second swarm as "yellow." During this period they eat less, probably only up to half of their body weight each day. After the second egg laying, again half of the remaining animals would continue to swarm for four to 5 days, but cause little concentrated economic damage, because their appetite is further reduced and most of them will die off quite soon after the second egg laying. Only a small number of insects may lay a third set of eggs.

A second important determinant of the economic damage caused by locust is the kinds of crops it feeds on. Especially zone 2, the Souss valley, contains some of Morocco's most valuable cropland. A locust infestation in the Souss, especially if it should take place at a critical period, such as in February or March, when the citrus trees are in bloom and thus are particularly vulnerable to locust attack, could cause enormous economic damage. On the other hand, if locust feed on rangeland, or on land that is left fallow or that has no economic use, the economic damage caused by the locust will be minor.

Locusts do not single out particular crops for feeding on. Wherever the winds carry them, they will feed on whatever biomass they find. The chance that they will land on a particular crop, say a citrus orchard, is thus pretty much proportional to the acreage of citrus orchards in the overall acreage of green land within the swarms flight path. The reason for taking only "green" land, i.e. land with at least some vegetation on it, is that locust will rarely settle on bare ground, but keep migrating until some suitable land is found.

Table 1 presents a summary of the economic value of agricultural production in a number of different provinces of Morocco. Included in the summary is the economic value of rangeland (parcours) as a provider of fodder for the raising of livestock. Not included in this table are vegetables, even though they represent a substantial economic value, particularly in the Souss. The reason for this omission is that most of the high value vegetable production is in greenhouses, and thus protected from much of the damage that locusts would cause. The area not protected under greenhouses is very small, so that the probability that locust would land on such a vegetable field is also very small (less than .01 percent).

In table 2 the acreage for the different crops is set in relation to total green area. It is assumed that 1/2 of the total geographic area, outside of agriculturally used land or forests, also contains some vegetation that could provide fodder for locust. Forage and leguminous production (lentils, peas etc.) have been combined into "Other agricultural production," and dates have been added to "Other tree crops." The estimates of economic value per hectare given in table 2 are derived from the estimates of total value of production by zone, given in table 1. The forest area was assumed to be used as rangeland as well as for the production of wood. Thus the economic value of production per hectare of forest was taken to be the sum of the value for rangeland plus an estimate of the economic value of wood production. The later figure was estimated by dividing the total value added in the Moroccan forestry sector by the total acreage of forests in Morocco.

Which areas are likely to be infested by locusts depends on the migration path of swarms. Predicting the direction and speed of migrating locust swarms involves numerous variables. The most important is clearly wind. Even though locusts fly by flapping their wings, they do so primarily to stay aloft and not to propel themselves in any particular direction. The direction of swarm displacement is virtually always within a few degrees of the downwind direction. Furthermore, locust have never been documented to migrate at speed exceeding the windspeed. In fact since they tend to keep themselves aloft by flying <u>against</u> the wind, and since some locusts, especially at the front edge of a swarm tend to settle at any time, the speed of swarm displacement is typically only about one half of windspeed, and rarely in excess of 10 km/h. Median speeds of swarms that have been followed is around 5 km/h.

Since a swarm tends to migrate about six to eight hours each day, we can conclude that the typical distance travelled is between thirty and forty km for each day of the migration. This figure applies to migrations across open territory with moderate vegetation. If there is little or no vegetation, locust will travel longer, and at higher speeds, since they will settle less often during the day. In this case daily displacements might reach 80 to 100 km. In the mountains, in cool weather, and when there issufficient vegetation, speeds will be slowed to as low as ten km/day or even zero, if a swarm has found good vegetation and winds are modest.

Finally, it must be noted that crops are not always equally vulnerable to locust attacks. In the early months cereals crops, for example, are remarkably resistant to locust attacks. If the plants are very small, so that locust destroy them completely, it is usually possible to re-seed, albeit with reduced prospects for high yields. Later, cereals fields may be thinned out somewhat by locust, but rarely to the point of complete loss. In the month

TABLE 1

AREA, PRODUCTION & ECONOMIC VALUE OF AGRICULTURE IN DIFFERENT AREAS OF MOROCCO

Province by Zone	Pastures Econ.Val.per MFU: 0.8			Cereals Econ.Val.per t: 1040.0			Legum. Econ.Val.per t: 3000.0			Forage Econ.Val.per t: 800.0			Olives Econ.Val.per t: 1500.0			Almonds Econ.Val.per t: 10000.0			Citrus Econ.Val.per t: 2000.0			Dates Econ.Val.per t: 5000.0			Misc. Econ.Val.per t: 2000.0		
	Land in use (1000ha)	Annual Product. (MFU)	Economic Value (MDH)	Land in use (1000ha)	Annual Product. (100t)	Economic Value (MDH)	Land in use (1000ha)	Annual Product. (100t)	Economic Value (MDH)	Land in use (1000ha)	Annual Product. (100t)	Economic Value (MDH)	Land in use (1000ha)	Annual Product. (100t)	Economic Value (MDH)	Land in use (1000ha)	Annual Product. (100t)	Economic Value (MDH)	Land in use (1000ha)	Annual Product. (100t)	Economic Value (MDH)	Land in use (1000ha)	Annual Product. (100t)	Economic Value (MDH)	Land in use (1000ha)	Annual Product. (100t)	Economic Value (MDH)
Zone 1a:	4067.2	488.1	390.5	68.3	1157.2	120.3	1.4	2.9	0.9	5.6	196.0	15.7	10.1	137.4	20.6	0.3	17.9	17.9				21.2	137.8	68.9	3.8	140.2	28.0
Errachidia	1463.8	175.7	140.5	17.4	221.1	23.0	0.3	2.9	0.9	3.0	105.0	8.4	6.5	88.4	13.3	0.8	3.3	3.3				5.6	34.0	18.2	0.6	22.1	4.4
Ouarzazate	1964.3	235.7	188.6	41.6	843.6	87.7	1.1	0.0	0.0	2.5	87.5	7.0	2.0	38.1	5.7	3.1	12.9	12.9				13.0	84.5	42.3	3.2	118.1	23.6
Ouaouizarte	562.1	67.5	54.0	5.8	61.4	6.4							0.6	8.2	1.2			0.0									
Tata	77.0	9.2	7.4	3.5	31.1	3.2				0.1	3.5	0.3	0.2	2.7	0.4	0.4	1.7	1.7				2.6	16.9	8.5			
Zone 1b:	3179.7	381.6	305.3	225.9	1660.3	172.7	2.6	18.3	5.5	3.3	115.5	9.2	9.2	125.1	18.8	3.5	14.6	14.6	7.7	1066.7	213.3				3.9	143.9	28.8
Oujda	438.9	52.7	42.1	105.1	1314.2	136.7	0.8	2.6	0.8	1.8	63.0	5.0	4.4	59.8	9.0	3.1	12.9	12.9	7.6	1052.8	210.6				3.1	114.4	22.9
Douiouane	568.5	68.2	54.6	19.1	149.9	15.6	0.9	7.9	2.4	1.3	45.5	3.6	4.3	58.5	8.8	0.4	1.7	1.7	0.1	13.9	2.8				0.6	22.1	4.4
Figuig	2172.3	260.7	208.5	21.7	196.2	20.4	0.9	7.8	2.3	0.2	7.0	0.6	0.5	6.8	1.0			0.0							0.2	7.4	1.5
Zone 2:	125.1	15.0	12.0	236.8	1975.4	205.4	0.6	4.9	1.5	4.3	150.5	12.0	7.4	100.6	15.1	5.7	23.7	23.7	18.5	2562.8	512.6	0.8	5.2	2.6	2.5	56.1	11.2
Agadir/Taroud.	125.1	15.0	12.0	149.9	1250.5	130.1	0.6	4.9	1.5	4.1	143.5	11.5	6.7	91.1	13.7	4.6	19.1	19.1	18.3	2535.1	507.0	0.1	0.7	0.3	2.2	45.0	9.0
Tiznit				86.9	724.9	75.4				0.2	7.0	0.6	0.7	9.5	1.4	1.1	4.6	4.6	0.2	27.7	5.5	0.7	4.6	2.3	0.3	11.1	2.2
Zone 3:	1230.0	147.6	118.1	2447.4	32546.2	3384.8	116.4	983.8	295.1	48.6	1702.4	136.2	140.2	1906.7	286.0	27.3	113.6	113.6	14.5	2008.7	401.7				53.3	1966.8	393.4
Anfal	40.0	4.8	3.8	121.7	1913.4	199.0	3.8	35.8	10.7	1.8	63.0	5.0	7.3	99.3	14.9	14.5	60.3	60.3	0.2	27.7	5.5				2.3	84.9	17.0
Beni Mellal	118.8	14.0	11.2	200.8	4206.2	437.4	4.2	34.1	10.2	8.0	280.0	22.4	10.6	144.2	21.6	0.4	1.7	1.7	9.0	1246.8	249.4				0.8	29.5	5.9
Ben Slimane	2.6	0.3	0.2	90.3	2252.7	234.3	26.7	193.6	58.1	10.0	350.0	28.0													13.3	490.8	98.2
El Jadida	49.5	5.9	4.0	236.1	3919.3	407.6	11.2	88.8	26.6	8.8	308.0	24.6							0.2	27.7	5.5				23.0	848.7	169.7
El Kalaa	246.6	29.6	23.7	324.6	2217.2	230.6	8.1	78.4	23.5	9.2	322.0	25.8	40.0	518.4	87.8	0.1	0.4	0.4	0.8	110.8	22.2				1.7	62.7	12.5
Essaouira	1.5	0.2	0.1	185.5	2908.6	302.5	2.7	13.2	4.0	9.0	1.4	0.1	11.2	152.3	22.8	8.2	34.1	34.1							3.2	118.1	23.6
Khouribga	70.0	9.4	7.5	122.2	1525.6	158.7	0.2	0.9	0.3	0.3	10.5	0.8	0.4	5.4	0.8										0.2	7.4	1.5
Marrakech	224.0	26.9	21.5	334.1	3408.8	375.3	4.3	1.2	0.4	3.6	126.0	10.1	54.4	739.8	111.0	4.1	17.1	17.1	6.1	568.0	113.6				7.1	262.8	52.4
Safi	257.0	30.8	24.7	331.9	3284.0	341.7	12.0	164.6	43.4	5.9	206.5	16.5	7.8	106.1	15.9										1.4	51.7	10.3
Settat	214.0	25.7	20.5	499.2	6708.4	697.7	43.2	393.2	118.0	1.0	35.0	2.8	4.5	61.2	9.2				0.2	27.7	5.5				0.3	11.1	2.2

TABLE 2

DISTRIBUTION OF AREA BY AGRICULTURAL USE IN THE PRINCIPAL ZONES OF INTERVENTION FOR THE USAID PROJECT

Province by Zone	Geographic Area Total (1000ha)	Geographic Area of which "Green" (1000ha)	Geographic Area of which "Green" (prcnt.)	Forest (1000ha)	Forest (prcnt.)	Rangeland (1000ha)	Rangeland (prcnt.)	Cereals (1000ha)	Cereals (prcnt.)	Other Agricult. (1000ha)	Other Agricult. (prcnt.)	Olives (1000ha)	Olives (prcnt.)	Almonds (1000ha)	Almonds (prcnt.)	Citrus (1000ha)	Citrus (prcnt.)	Other Tree Crops (1000ha)	Other Tree Crops (prcnt.)
Zone 1:	15501.0	9989.3	64.11%	215.6	2.16%	4067.2	40.72%	68.3	0.68%	7.0	0.07%	10.1	0.10%	4.3	0.04%			25.0	0.25%
Errachidia	5958.5	3755.1	63.02%	53.7	1.43%	1463.8	38.98%	17.4	0.46%	3.3	0.09%	6.5	0.17%	0.8	0.02%			6.2	0.17%
Ouarzazate	4155.0	3145.1	75.69%	103.6	3.29%	1964.3	62.46%	41.6	1.32%	3.6	0.11%	2.8	0.09%	3.1	0.10%			16.2	0.52%
Goulemin	2875.0	1724.7	59.99%	6.0	0.35%	562.1	32.59%	5.8	0.34%			0.6	0.03%						
Tata	2592.5	1364.4	52.63%	52.4	3.84%	77.0	5.64%	3.5	0.26%	0.1	0.01%	0.2	0.01%	0.4	0.03%			2.6	0.19%
Economic Value of Annual Prod.		69.3 DH/ha		134 DH/ha		96 DH/ha		1761 DH/ha		2371 DH/ha		2040 DH/ha		4163 DH/ha				3876 DH/ha	
Zone 2:	2933.0	2151.1	73.34%	967.5	44.98%	125.1	5.82%	236.8	11.01%	4.9	0.23%	7.4	0.34%	5.7	0.26%	18.5	0.86%	3.3	0.15%
Agadir/Taroudant	2237.0	1666.4	74.49%	784.2	47.06%	125.1	7.51%	149.9	9.00%	4.7	0.28%	6.7	0.40%	4.6	0.28%	18.3	1.10%	2.3	0.14%
Tiznit	696.0	484.7	69.64%	183.3	37.81%			86.9	17.93%	0.2	0.04%	0.7	0.14%	1.1	0.23%	0.2	0.04%	1.0	0.21%
Economic Value of Annual Prod.		430.5 DH/ha		134 DH/ha		96 DH/ha		867 DH/ha		2755 DH/ha		2041 DH/ha		4158 DH/ha		27708 DH/ha		4182 DH/ha	

before harvest, however, cereals are extremely vulnerable, an infestation by a locust swarm can easily cut yields per hectare in half. In two days, a swarm can completely destroy a cereals field. Tree crops, on the other hand are extremely vulnerable during the flowering stage, and then again late in the year when the new growth is beginning to set in. They are also vulnerable to multi-year damage from limbs broken by the weight of the locusts or from locusts feeding on the bark.

Table 3 presents a calendar of the estimated damage that a typical locust swarm would cause to different crops, as a function of the month of the year. The damage is expressed in the form of a reduction in the current year's output value, even though it might in fact occur over several years. It has to be kept in mind that these estimates are informed guesses at best. Furthermore, even if they are fairly true to the expected value, the variance around this is extremely high. It is possible that a locust swarm causes no appreciable damage to a specific field, while another swarm destroys it completely in one night.

Combining these three elements, age of the locust, what is the likely area where it will feed (location and direction of migration), and likely damage it will cause there, which depends on the month of the year, we can arrive at an estimate of the damage that any particular swarm might cause and thus the benefit of neutralizing this swarm. Consider a hypothetical swarm of pink (immature) locust that has been identified 160 km South of the Anti Atlas in zone 1. Assume that the animals in this swarm are of average size (2 grams) and the swarm is of average density (100 locust/m2). Each hectare of this swarm thus contains about 2 tons of locusts. The economic threat that this swarm poses, the expected economic damage that such a swarm would cause, is given in Table 4.

The estimated economic damage that each ton of locusts in this swarm could cause was calculated in the following manner: Assume that it is February and that prevailing winds at this time of the year are likely to cause that swarm to migrate North, on a pretty direct path towards the Souss valley. Over the next four days, this swarm will migrate north until it reaches the foot of the Anti Atlas. Thereafter it will take about 8 days to cross the Anti Atls. During these 12 days the swarm has a 2.16 percent chance of landing in a forest area (see table 2), a 40.72 percent chance of landing on rangeland, etc. If it lands in a forest area, it will cause economic damage amounting to approximately 20 DH/ha (15 percent of 134 DH). But since there is only a 2.16 percent chance it will land in a forest area, the expected damage to forestlands is only .434 DH per hectare of the locust swarm, or .217 DH/ton of locust. On rangeland it would cause damage amounting to 14.4 DH/ha or 7.2 DH/ton of locust which, weighted by the 40.72 percent probability that the swarm will land on rangeland, amounts to expecteddamage of 5.86 DH/ha or 2.93 DH/ton of locust. Summed over all crops and land types and properly weighted we arrive at a figure of 5.9 DH/ton of locust. This is the daily damage that this swarm is expected to cause over the next four days while it migrates towards the southern rim of the Anti Atlas. But since some locusts will have died of natural causes in the meantime, or may have been blown by the winds into the desert or out to sea, not all the animals in the original swarm will reach the mountains. Assume that 80 percent of the

TABLE 3

Estimated Damage from a One Day Locust Infestation
(in % of Annual Production)

Month:	Cereals	Forest & Rangeland	Other Agricult.	Olives	Citrus	Almonds	Other Tree Crps
January	-15%	-10%	-20%	-20%	-5%	-5%	-0%
February	-20%	-15%	-50%	-35%	-70%	-5%	-15%
March	-30%	-20%	-30%	-80%	-70%	-70%	-70%
April	-50%	-20%	-10%	-40%	-50%	-70%	-70%
May	-20%	-20%	-0%	-40%	-35%	-30%	-30%
June	-0%	-15%	-0%	-30%	-30%	-5%	-20%
July	-0%	-10%	-0%	-30%	-20%	-0%	-20%
August	-0%	-10%	-0%	-30%	-10%	-0%	-10%
September	-0%	-5%	-0%	-30%	-10%	-0%	-10%
October	-0%	-5%	-0%	-30%	-30%	-0%	-10%
November	-5%	-10%	-90%	-25%	-30%	-0%	-5%
December	-5%	-10%	-90%	-20%	-25%	-0%	-0%

TABLE 4

Expected Economic Threat from a Hypothetical Swarm

Assumptions:

Average Density in original swarm	2.0 tons/ha
Number of days migrating in Zone 1	12.0 days as immature adults ("pink")
of which in the Anti Atlas	8.0 days as immature adults ("pink")
Number of days migrating in Zone 2	3.0 before first egg laying ("pink")
	5.0 after first egg laying ("yellow")
Proportion reaching the Anti Atlas	80.0 % of original swarm
Proportion crossing the Anti Atlas	70.0 % of those reaching Anti Atlas
Proportion forming second swarm	60.0 % of those crossing Anti Atlas

	Economic Damage per ton of locust				Estimated Damage from a One Day Locust Infestation															
Month:	Zone 1	Zone 2 "Pink"	Zone 2 "Yellow"	Total (DH/ton)	Forest DH/ha(avg.)	Forest pct.	Rangeland DH/ha(avg.)	Rangeland pct.	Cereals DH/ha(avg.)	Cereals pct.	Other Agricult. DH/ha(avg.)	Other Agricult. pct.	Olives DH/ha(avg.)	Olives pct.	Almonds DH/ha(avg.)	Almonds pct.	Citrus DH/ha(avg.)	Citrus pct.	Other Tree Crops DH/ha(avg.)	Other Tree Crops pct.
January	35.6	30.3	15.1	81.0	13	-10%	10	-10%	160	-15%	506	-20%	408	-20%	208	-5%	1395	-5%	0	0%
February	61.4	170.4	85.2	317.0	20	-15%	14	-15%	214	-20%	1265	-50%	714	-35%	208	-5%	19396	-70%	587	-15%
March	115.5	191.8	95.9	403.2	27	-20%	19	-20%	320	-30%	759	-30%	1632	-90%	2912	-70%	19396	-70%	2738	-70%
April	122.0	164.4	82.2	368.6	27	-20%	19	-20%	534	-50%	253	-10%	816	-40%	2912	-70%	13854	-50%	2739	-70%
May	78.4	103.9	52.0	234.3	27	-20%	19	-20%	214	-20%	0	0%	816	-40%	1248	-30%	9698	-35%	1173	-30%
June	46.5	71.7	35.8	154.0	20	-15%	14	-15%	0	0%	0	0%	612	-30%	208	-5%	8312	-30%	782	-20%
July	35.1	48.4	24.2	107.8	13	-10%	10	-10%	0	0%	0	0%	612	-30%	0	0%	5542	-20%	782	-20%
August	36.1	27.9	13.9	71.9	13	-10%	10	-10%	0	0%	0	0%	612	-30%	0	0%	2771	-10%	391	-10%
September	19.2	25.1	12.5	56.8	7	-5%	5	-5%	0	0%	0	0%	612	-30%	0	0%	2771	-10%	391	-10%
October	19.2	65.1	32.6	116.9	7	-5%	5	-5%	0	0%	0	0%	612	-30%	0	0%	8312	-30%	391	-10%
November	37.9	76.1	38.0	152.1	13	-10%	10	-10%	53	-5%	2276	-90%	510	-25%	0	0%	8312	-30%	196	-5%
December	34.9	65.5	32.8	133.2	13	-10%	10	-10%	53	-5%	2276	-90%	408	-20%	0	0%	6927	-25%	0	0%

insects in the original swarm will reach the Anti Atlas and be blown up its southern slope for another eight days. The total damage caused by this swarm in zone 1 is thus given by 4x5.9+.8x(8x5.9)=61.4 DH/ton of locusts in the original swarm.

Finally, there is a 70 percent chance that if the swarm reached the Anti Atlas it will reach the Souss valley, or a 100 percent chance that 70 percent of the swarm that reached the Anti Atlas (56 percent oft the original swarm) will reach the Souss valley. There they will live another 3 days before laying their first set of eggs. After the first egg laying, 60 percent of the animals that arrived in the Souss will reform in a second swarm and migrate for another 5 days as mature (yellow) adults before laying a second set of eggs and ultimately dying.

During this period the locust have a 44.98 percent chance of feeding on forest where they would cause about 20 DH/ha of damage each day, a 5.82 percent chance of feeding on rangeland causing 14.4 DH/ha of damage each day, etc. The mechanics of the calculations, and the culmmulation of the various damage estimates is carried out in exactly the same manner as for zone 1. The resulting expected damage in zone 2 amounts to 255.6 DH/ton of locusts in the original swarm, 170.4 DH/ton of which before the first egg laying, and 85.2 DH/ton between the first and the second egg laying. Any additiona. damage caused by locusts that live past the second egg laying is disregarded, since only a fraction live that long anyway, and their appetite is significantly reduced so that they cause only very small concentrated economic damage.

To recapitulate: Each ton of locust in the original swarm can be expected to cause about 61.4 DH of damage in Zone 1 and about 255.6 DH (170.4+85.2) in the Souss valley for a grand total expected damage of 317 DH. Note that the economic benefit of treating the same swarm farther south or east, from where it has a lower probability of reaching the Anti Atlas at a point from where it can threaten the Souss valley, or at a different time of year when the crops, especially citrus, are less vulnerable, has significantly smaller economic benefits. For a different time of year one would also want to adjust the expected migration path, since prevailing winds will be different. On the other hand, treating a similar swarm on top of the Anti Atlas mountains, from where it would be virtually certain to be blown into the Souss, would have significantly higher economic benefits.

These calculations are in fact much simpler than they appear in this rather lengthy exposition. For each day the expected damage that a swarm will cause is given by

$$D = p_i (d_{it} * V_i)$$

where D is the expected damage, p_i is the probability that a swarmwill land on a field of type i (e.g. forest, cereals etc.) and is taken to be proportional to the total acreage of this type in the overall "green" area (see table 2), d_{it} is the damage that would be caused to such a field at this particular time t (see table 3), and V_i is the economic value of annual production per hectare (see table 2). By adding these daily expected damage

estimates over the remainder of the expected life of a swarm a total estimate of expected damage can be obtained. These sorts of calculations are best done automatically with a computerized spreadsheet or database program. It would be rather simple to construct a program for a micro computer which, after entering the location, approximate size and estimated age of a swarm, would combine this information with the values contained in the tables provided here as well as a forecast of wind direction and speed and then calculate an estimate of the likely damage that this particular swarm would cause to agriculture, and thus of the benefit of neutralizing this swarm. Breaking up the provinces into smaller agricultural zones with differing densities of the various crops would improve the quality of the estimates without increasing the complexity of the task, provided it is carried out with the aid of a micro-computer.

The Economic Benefit of Preventing Progeny

By killing locusts before they have laid their eggs we are able to prevent locusts in future generations. Normally this could have very attractive economic benefits, since these future locust would also have the potential of causing economic damage in turn. The current circumstances, however, raise questions about this benefit, at least for some parts of Morocco.

As pointed out above, zone 1 is located right next to areas of northern Mauritania and southern Algeria, where locust cannot be treated. For all intents and purposes, these breeding grounds provide an infinite supply of locusts to zone 1. These breeding grounds are more than capable to produce all the locusts that could fit into zone 1, irrespective of any "indigenous locust production" within zone 1. Put differently, preventing locusts from being born in zone 1 has probably only a marginal impact on the total locust population that will be found in zone 1 next year. It will have an impact on the number hoppers; however, hoppers cause little damage and, since they do not migrate large distances and are on the ground all the time, can be readily treated if necessary.

Indirectly, however, locusts born in zone 1 may have an influence on next year's population. Locusts migrating south from zone 1 will reproduce in the Sahel and their offspring will migrate back north next fall. If it is possible to thin out the population so much, that the locust escaping south will return to a solitary phase, and if the breeding grounds in the Sahel are not being replenished by locusts from other parts of Africa, it might be possible to break the plague and have no return of the locust next year. However, this is an all or nothing proposition. If a sufficiently large number escapes back south, whether from Morocco or from Algeria and northern Mauritania, so that they remain in the gregarious phase, or if gregarious locusts return from other parts of Africa to the Sahel, the number of locust migrating back into Morocco next year will be essentially determined by theavailability of suitable breeding grounds in the Sahel, and not by the size of the parent populations. In other words, if a sufficiently large number escapes to retain the gregarious phase, it makes very little difference whether twice or three times as many escape. The number coming back next year will depend on suitable breeding grounds, and thus rainfall, and not on how many escaped.

Considering that some locusts will almost certainly escape from northern Mauritania, where for security reasons no control is possible, and that some locusts have already escaped on the Red Sea coast, it seems very likely that gregarious populations will breed in the Sahel next summer, regardless of whether locust escape from Morocco or not. Nevertheless, if opportunities to effectively thin out the locust population present themselves, they should be seized. The pay-offs from breaking the plague are large enough to warrant some efforts at population control, even if the chance of ultimate success may be small. For the project at hand we view the effect on total populations as an additional benefit. The project is essentially justified on the basis of protecting Moroccan agriculture. If, in addition, it also contributes to a reduction in locust populations in future generations, this is an additional unquantified benefit.

The situation is slightly different in zone 2. Zone 2 is somewhat protected from zone 1, so having hoppers and locust born in zone 2 could increase the overall number of locust in zone 2. Nevertheless, preventing this would be of limited economic benefit for two reasons. First, the natural conditions are such, that natural hopper mortality in the Souss valley would probably be quite elevated. Second, the Souss valley is fairly densely populated and few hopper bands would escape detection. They could be treated readily and inexpensively, e.g. with baited insecticides from the ground.

Finally, if a swarm has a good chance of reaching the Souss valley, the economic benefit of destroying it will be very high. Adding to this the additional benefit of preventing progeny will have no influence on our decision to destroy that swarm. In other words, in a few days a swarm of locusts in the Souss valley can cause sufficient direct economic damage to justify its destruction regardless of any progeny it might also produce.

Economic Costs of Killing Locusts

The economic cost of treating locust swarms consist of the financial cost of operating the treatment equipment, including pesticides, and the environmental costs caused by the spraying. The cost have to be normalized to a "per ton of locust killed" basis so that they can be compared to the benefit figures developed above. In practical terms this means that the total costs of treatment per hectare have to be divided by the average density of locust per hectare and by the kill efficiency.

Average financial cost of spraying operations per hectare during the past campaigns are given as averaging around $24.- (approx. 200 DH/ha). The environmental cost per hectare are virtually impossible to ascertain, since they depend in large part on where the spraying is carried out and by what means. But this does not imply that they are negligible. For example, the massive spraying currently taking place is bound to have significant negative impacts on the honeybee population in southern Morocco. while in a hive, honeybees are somewhet protected from contact poisons such as malathion. However volatile insecticides such as DDVP can effectively eliminate honeybee populations, even if they are in hives. This will harm not only the beekeeping industry, an important source of revenue particularly for the poor, but will also impact on pollination of fruit trees in the future. If in order to protect the citrus crop the GOM undertakes such massive spraying that a large proportion of all flying insects are effectively wiped out, this years crop may have been saved at the expense of crops in future years.

56

Groundwater quality may also suffer from massive spraying of some insecticides. Fortunately, USAID's pesticide of choice, malathion, breaks down rather rapidly if exposed to ultraviolet light and thus may already be effectively neutralized by the time it reaches the groundwater stream. Nevertheless, in a part of Morocco where water is very scarce, poisoning the groundwater has very significant economic costs. At least in a qualitative sense, these have to be taken into account. Spraying ought to be confined to targets where economic benefits are clearly so large as to offset substantial environmental costs, and to areas which are not environmentally sensitive.

Recognizing that the financial costs underestimate the economic cost we can nevertheless use them for a planning figure. Assume that spraying a swarm of 1000 ha is considered. This swarm is located in a flat area highly suitable to aerial spraying. Assume that the average density of locusts over the entire area that will be sprayed is about 100 per square meter or 2 t/ha. Assume that spraying will take place early in the day so that a kill efficiency of over 80 percent can be expected. In fact this high efficiency is probably sufficient to eliminate the swarm as the surviving 20 percent are likely to be disbursed and no longer represent any real threat. We can thus assume a killefficiency of 100 percent. At the stated density, the cost of killing or neutralizing one ton of locust is therefore about one half of the cost of spraying one hectare, approximately 100 DH.

Comparing this number to the estimated benefit above results in an attractive benefit/cost ratio of over one in the fall and over 3 in the spring. But if the swarm should be sprayed later in the day or under windy conditions, when kill efficiency will be lower, say 25 percent, we can no longer assume that the entire swarm will be neutralized. In this case we will kill only .5 tons of locust per hectare sprayed, and the cost will be 500 DH/ton eliminated, not counting environmental costs. This would be in excess off the potential benefit calculated above (see table 4)

Finally it should be pointed out, that swarms might be most effectively treated before they turn into swarms, i.e. in the hopper stage. Even though only about 10 percent of all hoppers may grow up into adult locusts, it may nevertheless be less expensive to kill 100 hoppers than to kill 10 adult locusts. To begin with, the amount of insecticide necessary to kill hoppers in their early instars is only about one half of the dosage necessary for adults. Secondly, hopperbands are more concentrated than adult swarms. Bands of newly hatched hoppers may reach densities of 30,000 per m2. Assuming that 10 percent would grow up into adult locust, we can effectively eliminate 3,000 potential locust by treating one square meter of a first instar hopper band. At an average density of 100/m2 the 3,000 locust would take up almost 1/3 of a hectare. Even in the fifth instar hopper bands may may reach densities of 1,000/m2. However, when marching, hopper bands tend to spread out and densities may fall to about 250-470 per square meter. Thirdly, hoppers migrate much smaller distances and are always on the ground. They can be treated from the ground at any time of the day with little risk of insecticide being carried away by the wind. They are also susceptible to treatment by different methods, such as baited insecticides and barrier spraying, which pose lower levels of risk to the environment.

Benefit/Cost of the USAID Project

Even under conservative assumptions, suppressing locust swarms in southern Morocco, south of the High Atlas mountains, can show attractive economic benefits. However, inappropriate spraying techniques as well as poor target selection for treatment, can rapidly erode the benefits and increase the treatment costs to where interventions are no longer justified. Whether the overall USAID project can be justified thus depends crucially on how and against what targets (swarms) the USAID provided resources will be deployed.

Several USAID sponsored observers of the Moroccan anti locust campaigns have noted the overall high standards and the general improvements in spray efficiency. Run in a military fashion (see institutional analysis), the Moroccan locust campaigns have so far been successful at preventing any serious incursions of locust into the Souss valley or other areas farther north. Nevertheless, these same observers have also remarked that there are large variations in the efficiency of operations, and errors such as spraying the same swarm repeatedly, spraying under unsuitable conditions, spraying swarms that have already laid their eggs and are dying off, are not infrequent.

The efficiency of locust campaigns depends on strategy, tactics and technique. Several USAID sponsored observers of the Moroccan anti locust campaigns have noted that overall the Moroccan locust teams are technically good to excellent. Blocks are marked adequately, spray planes fly at the proper height, swath width is good, dosage of insecticide is sufficiently controlled etc. Some additional improvements are possible and are planned under this project through the provision of better ground to air communication to allow spotters and pilots to maintain radio contact, and through better training of ground crews and pilots.

Similarly, the overall strategy, to protect the valuable crop land first, is appropriate. The coordination of the strategy from the PCC in Rabat, and the necessary logistic support to pre-position equipment and expendables, is carried out very well. USAID will maintain the dialogue on strategic issues with the GOM and assist wherever USAID assistance can be used. One example of that assistance is the provision of greenness maps, which are used regularly by the GOM for its strategic decisions.

The area where most improvements can be made is the tactical planning of the day-to-day operations. Where spray operations have yielded poor results, it has almost always been due to tactical errors such as spraying too late in the day, spraying when climactic conditions are unfavorable, treating swarms that pose little threat because they are not on a path to valuable crop land or because they have already been sprayed before. Another tactical error is failure to maintain adequate reserves (i.e. keeping some airplanes on the ground) to use against targets of opportunity or completing missions that other planes failed to complete.

The most frequent of these errors is spraying of swarms too late in the day or under adverse weather conditions (e.g. too cold. Under these conditions only a small fraction of the insecticide reaches its target and mortality is accordingly reduced. Ian Mckay who carried out the only actual tests of mortality in swarms sprayed in the late morning, found that mortality after 24 hours was only about 12 percent, despite generally good to excellent spray technique (adequate height of flight path, properly marked block etc.). At this mortality rate the cost per ton of locust neutralized was over 800 DH/t (1600 DH/ha) and, unless the swarm was virtually in the process of entering the Souss valley, was almost certainly higher than the damage this swarm was likely to cause. For all intents and purposes the flight time and the insecticide were wasted. It might have been better to wait until the conditions for spraying improved, so that a higher efficiency could be obtained (reducing cost), or until the threat posed by the swarm was better known (increasing benefits).

Fortunately, it does not seem that such errors are frequent enough to call into question the overall economic viability of the project. Nevertheless, care should be taken to minimize the waste of resources due to tactical mistakes. The project will provide training and technical assistance to reinforce the tactical capacity of the regional PCs from where USAID provided aircraft will operate. The technical assistant, in cooperation with the Moroccan commanders directing the locust campaigns, will seek to maintain adequate target evaluation and selection, assist in elaborating tactical options, and monitor the efficiency of individual spray missions to develop more information for tactical decisions. Even small improvements in tactics can have significant results on the benefit-cost ratio of the project. If, as part of this cooperation, the overall efficiency of the Moroccan locust campaigns can be improved, benefits will be that much higher.

ANNEX C

ENVIRONMENTAL ASSESSMENT UPDATE

ANNEX C

ENVIRONMENTAL ASSESSMENT UPDATE

1.0 Introduction

2.0 Insecticide Selection

3.0 Efficacy of Selected Insecticides for Locust Control

4.0 Application Methods and Equipment

- Aerial Application Targeting Operations
- Use of Fixed-Wing Aircraft
- Ground Application Methods

5.0 Ability of the Government of Morocco to Regulate or Control the Distribution, Storage, Use and Disposal of Insecticides

6.0 Effect of Selected Insecticides on Non-Target Organisms and the Natural Environment

7.0 Summary and Conclusions

8.0 Bibliography

9.0 Attachments

ANNEX C

ENVIRONMENTAL ASSESSMENT UPDATE

1.0 Introduction

An environmental assessment (EA) of the original Locust Control Project was duly completed in April 1988 in accordance with the Agency's 22 CFR 216 environmental procedures (see original PP). This document properly addressed all salient Agency concerns regarding the environmental aspects of this project to the extent feasible given the information and experience available on this subject at that point in time. However, much has happened since the completion of this original EA, and new information and insight has been gained regarding the current status of existing local control program operations and procedures and the most appropriate mechanisms for ensuring that Agency environmental concerns are being properly addressed. This EA Update is provided, therefore, to supplement the original EA findings and recommendations in areas where new information and experience has shown that this is desirable and necessary. It does not replace the original project EA where its conclusions are still valid and appropriate.

While it is hoped that the current locust plague can be successfully eradicated during the next year's cycle of operations, the EA Update also reflects the real possibility that the control program may require a longer term effort. In this interest recommendations provided below provide for longer-term institutional improvements in campaign environmental, health and safety operations as well as assistance for meeting more immediate, short-term campaign requirements in each of these areas.

2.0 Insecticide Selection

2.1 Original EA Comments: "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 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 1 is subject to change based on the outcome of additional planned field tests and finalization of the L/G Programmatic Environmental Assessment" (L/G PEA). p.5-4.

2.2 Information Update: During last year's Fall 1987 and Spring 1988 Moroccan campaigns, approximately 1.45 million liters of insecticides and 1.9 million liters of toxic organic solvent were sprayed over some 2.8 million hectares of Moroccan territory (see Table 2). U.S. Government donations, consisting of some 43,000 liters of carbaryl and 140,000 liters of malathion, comprised about 9% of the total pesticide use over this period. Similarly, approximately 1 million hectares of land have already been sprayed during the ongoing Fall 1988 campaign, including some 400,000 liters of USG-supplied malathion. In most instances, this coverage has proven to be generally

TABLE 1

LIST OF INSECTICIDES PROVISIONALLY APPROVED FOR USG USE IN LOCUST/GRASSHOPPER CONTROL ACTIVITIES (L/G PEA, TAMS/CICP, 1988)

Carbaryl	-	Appropriate for both aquatic and terestrial applications (but not around pollinating insects)
Diazinon	-	Use with caution in aquatic environments; not recommended for terrestrial use (due to toxicity to birds)
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

Table 2

1987/88 Morocco Locust Campaign Insecticide Treatments

Insecticides utilisés

- DDVP Technique	=	88.702 L
- Fénitrothion 500	=	120.600 L
- Fénitrothion 1000	=	407.290 L
- Malathion 950	=	781.561 L
- Carbaryl 40	=	42.784 L
- Diazinon 900	=	8.200 L
- Karaté 40	=	8.900 L
- Solvant Han	=	1 900 000 L

Soit un total de = 1.458.037 litres de pesticides et 1.900.000 litres de Solvant

Traitements

Les moyens mis en oeuvre par le Royaume du Maroc et l'aide apporté par la Communauté internationale ont permis de traiter depuis le début des opérations au 20 Juillet 1988 : 2.813.182 hectares répartis par P.C comme suit (superficies en hectares) :

P.C	PAR VOIE AERIENNE	PAR VOIE TERRESTRE	TOTAUX	%
GUELIMIM	759.789	138.050	897.839	31,92
TATA	314.466	120.508	434.974	15,46
LAAYOUNE	35.440	117.041	152.481	5,42
DAKHLA	8.300	108.710	117.010	4,16
OUARZAZATE	354,041	166.388	520.429	18.50
ERRACHIDIA	147.643	157.746	305.389	10,86
BOUARFA	219.813	136.975	356.788	12,68
OUJDA	2.400	25.872	28.272	1;00
TOTAUX	1.841.892	971,290	2.813.182	100

dont : larves = 1,201.245 ha
Adultes = 1,611 937 ha

adequate and reasonably effective for most Moroccan locust control objectives, both with regards to the quantities and types of pesticides employed and the area treated. However, in late-October and early-November 1988, weather changes and prevailing locust populations resulted in rapid, extensive northern movements to the southern edge of the Souss-Massa Valley area of southwestern Morocco - a major agricultural region of the country. These swarms were treated by the GOM with karate and delta-methrin (decis), the insecticides of local choice in agricultural areas of the country. The GOM indicated their intention to continue to use these products in similar such circumstances in the future. They also stated their desire to use USG-supplied aircraft in applying these insecticides where conditions so warrant.

Although not specifically included in the list of L/G PEA-approved insecticides presented in Table 1, both of these products belong to the category of pesticides known as pyrethoids, some of which are approved for USG use under specified conditions (i.e., lambda-cyhalothrin and tralomethrin). In accordance with the above GOM request, USAID applied for a waiver to allow the use of decis in USG-supplied aircraft (see Rabat 10817 in Attachment 1). This waiver was subsequently granted by AID/W on December 11, 1988 (see State 400174 also in Attachment 1). Thus, in addition to the insecticides specified in Table 1, future AID-assisted control operations in Morocco will also provide for the use of decis. This waiver for decis use is valid through September 30, 1990, or until such time as a new waiver is authorized by AID.

2.3 Recommendations for Future AID-Assisted Operations:

2.3.1 All ongoing AID-assisted locust control operations be restricted to the provision and/or use of the following insecticides: malathion, carbaryl, bendiocarb, dursban (chlorpyrifos), fenitrothion, diazinon, lambda-cyhalothrin, tralomethrin and decis (approved for use only). Eligibility of AID assistance for any of these chemicals in subject to change based on the outcome of additional planned field tests and finalization of the L/G PEA.

3.0 Efficacy of Selected Insecticides for Locust Control

3.1 Original EA Comments: "The efficacy of the eight chemicals selected for AID-funded locust control is treated in the L/G PEA 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." p. 5-6.

"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... 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." p. 5-11.

3.2 Information Update: While all of the above is still generally valid, there appears to be conflicting evidence regarding the performance of the various insecticides currently being employed in Moroccan program operations. The problem appears to relate primarily to local attitudes, practices and conceptions regarding the use of the selected insecticides, rather than to the efficacy of the products themselves. The following examples serve to illustrate the nature of this complex, multi-faceted problem area:

- During the Spring 1988 campaign, USAID provided some 43,000 liters of carbaryl to assist Moroccan control program objectives. Following initial applications of this product, there were serious concerns raised regarding its effectiveness in killing locusts, with a variety of possible explanations being suggested for this apparent failure. Subsequent, carefully controlled trials of this product conducted in Morocco, however, provided directly contrary results-that the carbaryl was effective for this purpose, even under rather adverse testing conditions (George Cavin, pers. communication). Further inquiry revealed that the real reason for the Moroccans' erroneous belief in the inefficacy of this product is the longer time span it requires to kill locusts, as it is a stomach rather than a contact poison. Additional local criticisms relate to the increased difficulty in working with this product (i.e., solid (vs. liquid) compound, dilution requirements, etc.). Thus, despite the direct evidence provided above, this insecticide is no longer used in local program operations in favor of easier-to-use, faster-killing, yet much more dangerous, products (e.g., DDVP). It should be noted that this same local criticism has also been levelled at malathion for the same reason specified above, however, to a lesser and continually decreasing degree.

- Other concerns expressed regarding insecticide efficacy result largely from the misapplication of the approved products under local conditions. The USAID-financed Entomologist/Environmental Monitoring Specialist cites several informal, personal observations of malathion being aerially applied under inappropriate environmental conditions (i.e., low temperatures, high condensation levels), with naturally sub-standard results (i.e., 12.5 percent insect mortality after 32 hours; Mckay, 1988). The reasons for this all-to-frequent occurrence include an insufficient understanding by campaign pilots and ground staff regarding the application requirements and specifications for the various campaign insecticides, lack of equipment to properly monitor and communicate ambient meteorological conditions, and the logistical difficulties of attempting to implement a far-flung campaign operation in a timely and effective manner.

Thus, the problems experienced to date in this area relate fundamentally to a lack of knowledge regarding the conditions of application and the methods of action of the various insecticides, as well as local preference for those products which are relatively easy to use and exhibit dramatic, quick-kill results. While the former issue can be dealt with through staff training and limited commodity support (see Section 4.3 below), the latter attitudinal question requires more thoughtful and imaginative remedial measures.

3.3 Recommendations for Future AID-Assisted Operations:

3.3.1 A series of field trials should be conducted to demonstrate the efficacy of approved locust control insecticides to local campaign staff under Moroccan conditions. The objective here is not to research the efficacy of the various products approved for use, but to educate local participating agency staff of their potential in this regard under local conditions when used in accordance with recommended instructions and procedures. Because of the difficulties inherent in tracking treated swarms to collect mortality data, it is recommended that control and treated insects be collected from spray blocks and confined in cages for this purpose. For such demonstration work, it is believed the normal "cage-effects" can be ignored. Suitable cylindrical cages can be constructed of mosquito netting or cotton fabric for this purpose. Mortality observations should continue for at least 4-5 days post-treatment to ensure adequate time for the slower-acting toxins. Emphasis should be placed on the demonstration of USG-approved insecticides (see Section 2.3 above) to shift prevailing local preferences away from the other, less desirable products currently being used in campaign operations. For maximum demonstration effect, these trials should be conducted to the greatest extent possible throughout all campaign areas with the active participation of different regional staff. Similarly, all trial results should be given the widest dissemination possible. In this manner, it is hoped that local preferences and procedures can gradually be adapted to the improved, proper application of safer, yet equally effective, compounds. The above trials should be conducted only with the assistance of trained entomologists and with appropriate use of kromecote (or equivalent) spray detection cards to assure that adequate spray deposits have been obtained.

3.3.2 All insecticides approved for inclusion in AID-assisted operations be used in strict accordance with salient research and product manufacturers' recommendations (e.g., L/G PEA (1988), various manufacturers' instruction/specification materials), with regard to area and type of application, dosages and concentrations, and under proper physical and environmental conditions. (Additional recommendations for proper handling and use of the approved insecticides are provided below).

4.0 Application Methods and Equipment

4.1 Original EA Comments: "The various insecticide application technologies commonly used in locust outbreak control are described in detail in the L/G PEA. 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." p. 5-5.

4.2. Information Update:

4.2.1 Aerial Application Targeting Operations - The Moroccans are using a network of vehicle teams to survey and follow locust swarms. These teams report by radio to regional Command Posts where the results are plotted and the decisions are made as to what action should be taken. All information is passed to the Central Command Post in Rabat. The system is basically very well organized; logistics are good. Ground survey teams are aided by use of helicopters to assist their activities in especially difficult terrain. Based on observations of the system working in Guelmim, Ouarzazate and Errachidia and conversations with the pilots who end up spraying the designated blocks, the existing survey system appears to be working fairly well, but could also benefit from certain minor improvements in targeting accuracy.

Spray block delimitation and flagging appears to be the weakest component of all field spraying operations. The Entomologist/Environmental Monitoring Specialist cites several personal observations of inadequate target delimitation procedures resulting in less than optimum aerial insecticide applications. Most of the problem here appears to be due to one or more of the following causes:

- inexperienced pilots and ground marking crews;
- poor pilot/ground crew coordination;
- inadequate spray block marking procedures; and
- inattention to prevailing meteorological conditions (i.e., wind speed and direction, humidity) within the immediate target area.

4.2.2 Use of Fixed-Wing Aircraft - As a result of the severity and extent of the recent Fall 1988 locust infestation, a decision was made to provide two large USG-supplied fixed-wing aircraft (i.e., DC-7s) to expand the area of coverage commensurate with the size and scope of the identified locust swarms. Although not expressly prohibited from use (see above), such aircraft are not recommended for normal locust control operations due to their reduced targeting specificity and increased potential for non-target environmental impacts (L/G PEA). Although it is too early yet to tell the extent of any such non-target impacts, it is nevertheless considered prudent to establish an appropriate procedure for monitoring the effects of fixed-wing aircraft insecticide application to avoid or minimize any potential negative environmental impacts.

4.2.3 Ground Application Methods - In addition to the above two application areas, there are also concerns regarding campaign ground treatment operations. Specific issues here include proper insecticide application procedures and conditions, and worker safety. As might be expected, ground treatment operations generally experience greater problems in both of these areas than aerial applications. This is due to a variety of factors, such as the difficult terrain and working conditions, the greater number of people in contact with the chemicals, and the lower level of education and training of the average worker (vs. pilots). The Entomologist/Environmental Monitoring Specialist cites several observations of ground treatment mis-application and over-dosing, one of which appears to have resulted in extensive environmental damage on adjacent perennial vegetation (McKay, 1988). Equally important, however, are the greatly increased chances of worker exposure to toxic

chemicals in such circumstances through mis-applications, spray blowback, more frequent handling requirements and the almost inevitable lapses in protective clothing use due to the harsh and uncomfortable desert conditions. Preliminary evidence indicates that these worker safety concerns are largely warranted by the number of intoxications and reduced cholinesterase activity levels experienced to date among ground treatment staff (Fischer, 1988).

4.3 Recommendations for Future AID-Assisted Operations:

4.3.1 Aerial Application Targeting Operations -

4.3.1.1 The GOM should consider using small, high-wing profile, spotter aircraft to detect and monitor moving swarms of locusts. These aircraft are less expensive to operate than helicopters, and would free helicopters for use in more vital program activities.

4.3.1.2 To improve target delimitation practices, all ground crews should be trained in proper spray area delimitation, marking and swath flagging procedures. This course should include use of compasses, and map-reading and position reporting. This training should include a round-table discussion with participating campaign pilots to promote proper ground/air coordination of aerial spray operations.

4.3.1.3 Where necessary, control program pilots should receive training in the basic principles and practices of agricultural spraying operations delivered by an experienced spray pilot.

4.3.1.4 All campaign ground crews should be provided with VHF radio communications to facilitate ground/air coordination.

4.3.1.5 To facilitate aerial spotting by pilots, the GOM should consider distinctively marking all ground crew vehicles for ready identification from the air. Consideration should also be given to providing each ground crew with powerful, portable spot or strobe lights to assist pilot identification and orientation. (It is worth remembering that much of this work is carried out in darkness due to the specific local environmental conditions.)

4.3.1.6 Each spray block team should be supplied with instruments to record the wind, relative humidity and air temperature at the begining and end of treatment. These data should be collected for every treatment to provide, at a minimum, the opportunity for a retrospective analysis of any observed problems. Instruments needed are a handheld windmeter (anemometer), compass (wind direction), and robust psychrometer (this can be used to measure temperature and humidity simultaneously). Care should be taken to supply metric system instruments.

4.3.1.7 All spray block teams should be provided with a continuous supply of "kromecote" cards (or equivalent) for measuring spray deposit and droplet size. This information provides important feedback for improving aerial insecticide applications.

4.3.2 Use of Fixed-Wind Aircraft -

4.3.2.1 To the greatest extent possible, fixed-wing aircraft control operations should be undertaken with pre- and post-application environmental monitoring of the general target area. Monitoring information requirements would include: percent of target area coverage, percent of application falling outside of designated target area, method of target area delimitation, existing climatological conditions at the time of application, extent of non-target environmental impacts both within and outside of the designated spray area, and any other observations of interest. Should this recommendation not prove to be entirely feasible, it is suggested that at least a representative sample of such flights be monitored in this fashion over each cycle of operations (i.e., different climatological, topographical, biological, and regional situations with different insecticides). Post-application monitoring should continue for at least up to four days duration.

4.3.3 Ground Application Methods -

4.3.3.1 All ground treatment personnel should receive appropriate, practical training regarding the nature of the chemicals in use, techniques for their proper handling and application, and the various safety measures which need to be carefully observed in all such operations. These courses should be offered frequently to accommodate new employees and changing products. They should be delivered in the local language.

4.3.3.2 To minimize inefficient applications and worker exposure to chemicals, it is recommended that aerial treatment be used to the greatest extent possible. Where physical and logistical conditions permit such flexibility, aerial application should be considered the treatment method of choice in ongoing campaign operations.

5.0 Ability of the Government of Morocco to Regulate or Control the Distribution, Storage, Use, and Disposal of Pesticides

5.1 Original EA Comments: "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.

"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 Casablanca. This laboratory is well-equipped with standard pesticide analytical apparatus and instrumentation, including gas-liquid chromatographs and high performance liquid chomatographs. Quality assurance tests of pesticides imported for locust control are regularly carried out at this 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...

"The Ministry of Public Health (MOPH) is also 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 intoxification; 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 ...., 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 sound basic knowledge and understanding of safety, health, and environmental considerations. Shortcomings in facilities and equipment exist... 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." pp. 5-8 to 5-10.

The EA called for technical assistance and training to improve these aspects of campaign operations along with commodities support of such items as protective clothing and equipment for insecticide handling and spray personnel, cholinesterase testing kits and insecticide drum disposal equipment.

5.2 Information Update: While much of this original information is still valid and accurate, more recent evidence suggests that this important area of campaign operations is fraught with a variety of shortcomings and liabilities. Virtually every aspect of local insecticide handling and use practice contains serious problems, as evidenced by the alarmingly large numbers of chemical intoxications and reduced cholinesterase activity observed among campaign staff. Those workers at particular threat include the high chemical contact categories involved in aircraft refilling operations, ground treatment applications (see Section 4.3.3 above), and insecticide storage and mixing operations. To illustrate the concerns in this area of campaign operations, the following discussion has been excerpted from the draft report of the USAID-financed Pesticide Management and Health/Safety Expert (Fischer, 1988).

> Storage of pesticide drums on bare ground is inadequate as leaks cannot be detected and the soil can thus be directly contaminated. Even if the duration of storage is relatively brief, drums can be exposed to quite high temperatures. Average temperatures can reach 47C on the metal surface of the containers, and maximum temperatures can exceed that value considerably. With such temperatures, the pesticides can break down and become a hazardous waste. Further problems observed at the storage level include the general lack of warning signs, fire fighting equipment, fully adequate washing facilities (showers and eye-cleaning devices) and correct labeling of drums. Storage facilities were, in general, inaccessible to outsiders, but often close to dwellings.
>
> Handling of drums is very rough, and some centers have begun using bulldozers and fork lifts to move them. A drum disposal method is not yet operational and empty drums (punctured or

not) pile up at the PCs and sub PCs constituting a hazard. Reused drums are all insufficiently labeled and represent a hazard for those who cannot read or are not familiar with the operations. Except for one case where one-year-old carbaryl drums were found, there were no outdated stocks of pesticide. It appears that, on average, insecticide drums are stored about 1-2 months or less.

Workers at all PCs, Sub PCs and Operational Units wear protective suits and respirators. Protective suits were plastified or had a rainfast coat, most suits also had a hood. Rubber boots were worn mostly with pants covering them. Workers had rubber gloves, unfortunately, in most cases the quality was poor (easily broken) and this may have been a source of the recorded intoxications of people handling insecticides. The respirators were in good condition but it appears to be quite difficult to get the workers to wear them. Workers complained that protective gear was uncomfortable and hot, they would like to have something more adapted to Moroccan conditions, which is also more appropriate for the hardships of terrestrial treatments. The respirator is uncomfortable, and respiration through it is difficult. Many workers tend not to wear it. The protective gear quickly wears out or gets ruptured and continuous replacement is needed. In several cases, boots were in short supply. The protection equipment offers good protection from pesticide exposures. Intoxications result from negligence in properly using of the protective gear, from wearing equipment that is worn and torn (such as most of the gloves), and from reckless handling of a very toxic product.

The use of a respirator should be maintained and a continuous supply of filtering cartridges should be available. Since the instructions accompanying the masks were in a foreign language, confusion existed with regards to the frequency of filter changes. In general, filters are changed when the mask has strong pesticide smells, when it is difficult to breathe through, or if headaches and dizziness are felt. This is pretty much a decision of the user who needs to be made aware of these facts. It was difficult to identify in most cases how and where protective gear was washed. Many workers washed them at home. It could not be established if workers washed them in the same place clothes are washed. This was suspected in most cases. One worker was washing his protective suit in a bucket using bare hands to remove the pesticide stains. Some PCs sent all of the protective suits to a nearby laundry. The degree of knowledge at the laundry of the kind of material they were washing was not clear. The plastic eye protection was randomly worn, as visibility soon deteriorates while working with them on. However, eyes offer an almost direct route of pesticide penetration. The helmet with a plastic face coverage appears more adequate, and would also solve the problem of many workers not wearing a hat.

Refilling the planes with pesticides is the most hazardous situation, accounting for at least 50% of the intoxications. It occurs in the early morning when it is still dark. The crew of about 8 men works clumsily in the darkness. Pesticide is pumped out of the drums. When one drum has been emptied, the suction hose, with its terminal pipe, is withdrawn and put into the next drum. The suction pipe comes out of the drum soaked in pesticide, which is splashed and falls on the ground. As this hose-pipe assembly is heavy, workers literally hug it and get thoroughly wet with the insecticide (most often DDVP). The rubber hoses deteriorate and sometimes leak or break, splashing pesticide all around. The person holding the filling hose at the tank opening is usually too close, risking inhalation of the dense insecticide vapours, or being splashed with product. Not wearing the mask or wearing perforated gloves has resulted in intoxications and hospitalizations. The input of the technicians leading the crews is a key factor in the safety of this operation.

Sophistication and additions to the protective gear are not really going to eliminate intoxications if there is little assurance of it being properly worn. To address this situation, a near closed pesticide refilling circuit (for the airplanes) is needed, such that it will require the participation of only 1 or 2 workers. The refilling of the planes results in repeated daily pesticide spillages on the ground. A cement floor (instead of bare ground) to store the drums and contain spillages is needed at each airfield. The refilling areas are not delimited or isolated and, in general, no warning signs are posted. In theory, a nurse is always where pesticide is being handled, but transport to clinics and hospitals is sometimes a problem. Fire protection and washing facilities are in many cases insufficient.

The terrestrial treatment operations are the other important source of contamination with insecticide. Refilling the atomizers with insecticide often is hazardous. The other exposure situation is when one worker walks into somebody else's spray mist, or when changes in wind direction blow back the worker's own spray. Workers going back and forth to refill sprayers usually walk through pesticide mist. Negligence with the protective gear (mainly respirators and eye protection) in such circumstances may lead to intoxication.

Workers treat large extensions, usually on rough terrain or on hilly landscapes. This work is energy demanding and increases the heat inside the protective suits. Wearing a respirator becomes most uncomfortable. All of this results in workers neglecting the proper use of their protection gear. Seeking lighter, better adapted equipment may help. An alternative solution, however, is that terrestrial treatments be minimized,

and the involvement of helicopters in such areas be increased. Smoking, eating and drinking is forbidden during terrestrial spraying. Often there is a nurse accompanying the field crews to the treatment sites.

There are problems with the motorized atomizers used for terrestrial treatments. Not only are they very often "en panne", but in certain cases, there are safety problems, such as when rubber and plastic hoses deteriorate and leak pesticide which is spilled onto the worker and the ground. Drivers of trucks with pesticide for refilling the atomizers in the field should wear protective equipment as operating on irregular terrain is hazardous. Drivers of truck-mounted equipment (Micronair and large mistblower systems) should also wear protective gear. While spraying, the driver should keep the windows shut to avoid any of the spraying mist. With the mistblower cannon, a good deal of the spraying mist can whirl back towards the spraying unit.

The medical assistance for the locust control campaign is well organized, and in most cases works efficiently, reaching the crews in the field. There is a physician at each local hospital working with the PC, with other physicians and nurses distributed in the Sub PCs. Cholinesterase tests for workers are performed periodically, and more kits and replacement parts are beginning to be needed. Physicians and hospitals were all capable of treating intoxications by organophosphate insecticides but did not seem very sure about treating intoxications with lambda-cyhalothrin and deltamethrin, new compounds only recently incorporated into the campaign (see above). In most cases, they need technical data sheets of such new products. In some hospitals, the need existed for equipment to treat hospitalized intoxications. Some hospitals were in short supply of atropine and contraction. In some hospitals, the lack of pajamas to change for the pesticide-contaminated clothes of the arriving patients was a problem. Patients lay in bed with the same contaminated clothes they arrived in. Everybody seemed well aware of the safety problems, and seemed able to deal with intoxications, and to prevent hospitalizations by using the cholinesterase test as an early diagnostic tool. Many physicians complained that there would be less intoxications if the highly toxic DDVP insecticide were substituted by a less toxic, and equally effective, compound.

The workers are generally of poor caliber (many of them nomads, depending on the region), most of whom speak only Arabic and are not fully literate. In only specific cases, the crews remained relatively stable so that all workers could reach a certain level of proficiency. In most cases, when individuals leave, they are replaced by newcomers with no prior campaign

experience. The low educational level, and the fluctuating level of expertise in these crews, helps explain the difficulty encountered in convincing and enforcing the use of the protective equipment.

The regulatory aspects of pesticide use need to be updated. Although new regulations are supposed to be in progress, no documents have been made available for review to date. Such is also the case of the proposed new regulations for pesticide registration.

The Laboratory of the Plant Protection Division at Casablanca appears to be the sole local institution physically and technically capable of monitoring pesticide residues in the environment at present.

5.3 Recommendations for Future AID-Assisted Operations:

5.3.1. Fire fighting equipment should be placed in all insecticide mixing plants, storage areas, transport vehicles, and in all areas refueling and refilling planes with pesticides. The fire fighting equipment should include fire extinguishers, fire blankets, hose reels and a fire alarm. Sufficient water must always be available. It must be borne in mind that after a fire, contaminated fire-fighting water may flood into drains and waterways posing serious risks. Advice on fire-fighting equipment and facilities can be obtained from local fire authorities. Fire equipment locations should all be clearly identified with appropriate signs. There should be a crew trained to control a fire provided with the necessary equipment. Emergency drills should be conducted from time to time. Fuel or solvents and pesticides should be separated by distance or by a solid fire barrier. These barriers should be used at the mixing installations in Aït Melloul. Fire equipment must be regularly checked and maintained in good condition. Maintenance records should be kept.

5.3.2. Signs indicating smoking or eating restrictions, access restrictions, location of emergency equipment, need to wear protective gear for access, telephones and all escape routes must be clearly displayed. Symbols should be easily understood and should be in the local language. There should be symbols on pesticide drums indicating the toxicity of the different chemicals.

5.3.3. Considerable improvements are needed at the drum storage sites. The first requirement is a firm, impermeable base to avoid soil contaminations, and to contain and mop up spillages. This floor should be surrounded by a containment wall capable of containing a spillage of at least the total volume of liquid held by the largest of the drums, and any contaminated water from fire fighting operations. At the base of the containment wall, there should be a drainage gulley sloping to a sump. The sump should be periodically emptied and disposed of in a biodegradation pit (see below), or be highly diluted (1/10) and sprayed over a deserted area. Larger biodegradation units should also be constructed at the airfields to

contain the contaminated rinsing water from the plane's pesticide tank; alternatively, this water could also be sprayed over deserted areas. A simple way of flooring a storage site is by using several layers of heavy plastic covered by a 2-6 in layer of soil or clay or other absorbants. The storage site must be well ventilated and preferably roofed to prevent the deterioration of the insecticide, or its formulation, with the high desert temperatures. Asphalt is not recommended as flooring material because it softens with heat and with certain solvents.

All 200 litre drums should be stored on pallets, where leaks can be spotted and corrosion at the bottom of the tanks can be prevented. Two hundred liter drums may thus be stacked in two layers separated by pallets. All drums must be stored in such a way that there is sufficient space (aisles) for inspection and fire-fighting access. Mechanized handling of drums (fork lifts, bulldozers) should be available, and drums need to be arranged to permit the operation of such units. This would substantially reduce damage caused by dropping drums. Aisles should be marked with paint on the floor. Fuel should be stored separately from insecticide, or at least separated by a fire wall.

Storage requires careful inventory control and the rule of "first in, first out" should be applied. Regular inspections should be conducted. Drums should be identified with their arrival date. Storage facilities should be properly locked or surrounded by a fence. Storage should be in areas not subject to flooding and away from dwellings, offices, water sources, food and animals. Storage should be away from inhabited areas. If current facilities are close to dwellings or offices, cholinesterase tests should regularly be applied to the neighbouring individuals.

Storage areas must be provided with a good water supply for emergencies. Dry absorbent materials such as absorptive clay, charcoal, sand, sawdust, vermiculite, dry rags or paper should be at hand for cleaning (mopping up) leaks or spills on cement or plastic floors. After cleaning, these contaminated materials should be properly disposed of as hazardous wastes. Organophosphates are easily hydrolized with lime or sodium hypochlorite. This also applies to lambda-cyhalothrin. It is advisable to have such substances on hand to quickly decontaminate any spillages.

Biodegradation pits can be built to contain moderate amounts of toxic materials from cleanup of storage spillages. Pits 2 m in diameter and 2 m in depth, are dug in the ground. They should be lined with 10 cm clay and 2 cm lime, cement or plastic. Layers, 5 to 15 cms thick, of charcoal (at the bottom), lime and a source of organic matter, such as manure or plant residues containing biodegrading microorganisms, should be added to the pits. The pits should be kept moist. Anaerobiosis should be avoided. Added wastes (10-15cm thick) should be covered with a layer of soil. More layers of charcoal, lime, and organic matter, should be added as the pit becomes filled.

Pesticides should be stored in adequately labeled containers, including conventional toxicity warning symbols. All such labelling should be in the local language, since workers and technicians also need to know what kind of product they are handling. Paint should be used instead of stick-on paper labels which are easily lost. Old out-dated labels should be removed or covered with paint.

Employees should be trained on how to handle spillages and on emergency treatment of exposures, as well as to recognize the symptoms of over-exposure. Spillages on the ground (earth, gravel, etc.) should be shovelled off and put into closed containers for safe disposal. The use of water to clean up spillages on cement floors should be avoided since water disperses the pesticide, enlarging the contaminated area.

Food, feed or other articles intended for consumption by humans or animals should not be allowed in storage areas. First aid kits should be available in all storage areas. Workers must spend the least time possible in the storage areas. Medical authorities should be given full details of all pesticides being stored and used in the area. These recommendations apply to all insecticide and aircraft fuel storage areas, including Casablanca port areas.

5.3.4. Enforcement of the proper use of protective equipment could be improved up to a point. There seems to be a limited opportunity for improvement beyond which further improvements will prove very difficult. Additions to the current protective gear may increase the uncomfort presently felt and not necessarily improve protection, since wearing the equipment will perhaps always face some degree of inconsistency. In any case, lighter and more comfortable protective suits should be better accepted by field personnel.

5.3.5 To obtain a significant improvement in safety, the refilling operation needs to be simplified, the number of persons in contact with the product needs to be drastically reduced, and/or their contact made more sporadic (such as by limiting the frequency of terrestrial treatments (see Section 4.3.3 above) and/or alternating crews). At airport level, the use of cistern trucks with built-in pumps would offer a practically hermetic circuit from the cistern to the plane which could be operated by 1-2 workers (8-10 are currently involved). The more hermetic the refilling sequence is, the less will be the number of workers in contact with the product. A cheaper, and perhaps better alternative, is to place a cistern (or a cistern truck) on an elevated ramp, higher than the plane to be filled. The plane could then be gravity fed with a hose. There would be no pump (lower cost, no risk of fire and spillages), and the system can be handled by one worker. Efficient ball shut-off values should be placed at either end of the hose. Such systems should be imposed at every plane-operating center, if the number of intoxications (or low cholinesterase %) are to be drastically reduced and if work with DDVP continues. By working with cisterns, an important additional objective is also achieved: elimination of drum accumulations at airfields and storage areas.

There is an alternative system that could also help avoid the handling of the heavy pipe and rubber hose set presently used to transfer the product. Pipes (reaching the bottom of the drums) can be inserted into each drum, with the suction hose hand-clamped to the upper end of the pipe. When the drum is empty, the hose is unclamped and re-clamped to a similar pipe in the next full drum. This is a much easier and cleaner maneuver than transferring the entire hose and pipe assembly to each drum, resulting in substantive regular product spills and contaminations.

For future-year efforts, the Mission, with AID/W assistance, will explore modified methods for pesticide closed-system transfer, with the aim of developing minimum standards and specifications for use in all locust control efforts.

5.3.6. Pumps used for loading or mixing pesticides should have an antisplash shield covering them, and a receptacle at the base to contain leakages (see Attachment 2).

5.3.7 Many liquid insecticide formulations are based on flammable organic solvents (such as HAN, which is being used at Aït Melloul). Thus, in formulating and mixing plants using such solvents, there is always the risk of fire with the emitted vapours. For this reason, all electrical equipment and vehicles in the vicinity must not produce sparks.

5.3.8. Considering the general background of the field workers, the recommended training approach is to train the trainers. Train the permanent staff that works daily with the crew in the field. Such training courses should be 1-2 weeks long, staged at key regional locations. The course (or stage) should involve the participation of Moroccan scientists in the lecturing. All training should be conducted when campaign operations are in recess. An outline of such a course is included in Attachment 3. The courses should have a practical approach.

5.3.9 After a locust control effort, empty pesticide containers should be perforated, crushed, and buried. AID has adopted this policy to prevent the reuse of drums for unauthorized purposes such as grain or water storage. At least one hole should be made in the top and bottom and several around the sides. The tops of drums should never be removed since this will cause personnel to have excessive exposure to the residual pesticide within the drum.

Drums are best disposed of by piling on the soil surface and covering with a light layer of soil. Deep pits should never be dug since a major objective is to have the maximum separation between any residual pesiticide and shallow ground water.

If soils are low in clay content (very sandy), additional precautions are required. Either sprinkle kerosene or fuel oil (not gasoline) over drums and ignite, or sprinkle one kilo of hydrated lime (CA(OH)2) under and around each drum at the disposal site. If the drums are burned, care should be taken that there is a steady wind away from inhabited areas. If drums are sprinkled with lime, the alkaline environment will cause hydrolysis of the pesticides to less toxic by-products.

Soils have the maximum ability to degrade pesticides in the upper 6 to 12 inches of soil horizon. The small residual amounts of pesticides within the containers will easily biodegrade by the combined forces of hydrolysis and soil microbial decomposition.

An acceptable alternative to the above is smelting and reuse of by-products. This option should be used only where adequate air pollution control measures are in place.

The Mission will periodically monitor the status of GOM drum disposal procedures and practices.

5.3.10 Printed safety guidelines should be distributed in the local language to all campaign personnel and local extension agents. They should be based mainly on pictures. A similar type of publication should be devised for the general public. Greater emphasis should be placed on public education through use of the media (radio and television, as appropriate) to provide information on locust movements and spraying operations, and necessary health and safety precautions.

5.3.11 Hospitals, particularly the small ones, should be provided with pajamas for patients to change pesticide-contaminated clothes. Periodic checks should be made to ensure that all participating hospitals have sufficient medical supplies to treat chemical intoxications and burns. In addition, all concerned medical staff should receive up-to-date information and training regarding effective treatments for all chemicals currently in use in campaign operations.

5.3.12 Periods for rentry into a crop or other area treated by insecticides, by bees, animals and men should be known and publicized to prevent premature exposures. If unknown, wait 24-48 hours for reentry.

5.3.13 Protective gear is a consumable item. A sufficient stock of such equipment should always be available at each locust control center.

5.3.14 The use of DDVP in the locust control campaign is the main reason for the intoxications or low cholinesterase values observed. Research should be conducted to identify equally effective chemicals with lower acute toxicities (see Recommendation 3.3.1 above). In this regard, it is noted that any of the pesticides listed in Table 1 of this Update are preferrable alternacives to DDVP and are less toxic to humans.

5.3.15 The use of ramps and/or cushion tires is not presently working in avoiding the bashing of drums. Ramps have to be at least as wide as the length of the drum; otherwise, drums tend to fall off the ramp. Two men with gloves need to insure a slow and controlled drum descent to the cushioning tire.

5.3.16 There should be control over the quality of drums reused at Aït Melloul. Recycled drums are very bashed and ostensibly corroded. Ideally, only new drums should be re-used. Older drums should be professionally reconditioned prior to re-use (if specialized facilities for reconditioning exist in Morocco), or not re-used at all.

5.3.17 Protective clothes should be washed far from food, dwellings or potable water sources. A specific tub should be used for this purpose only. Long gloves must be worn for washing. After washing, clothes should be well exposed to sunlight to break down any remaining traces of pesticide. Contaminated rinsing water could be disposed of in a biodegradation pit or other environmentally safe disposal system. Protective clothes should only be worn when strictly necessary. They should never be taken home.

In washing the respirator, the filter cartridges should be removed. Water or soap must never wet the activated charcoal of the filter. Protective gear should be stored in a closed cabinet away from the insecticide storage site.

5.3.18 The GOM should organize a mobile team of knowledgable officials to periodically check all operations units to ensure that all recommended safety practices are being followed and to provide advice on shortcomings and improvements. This type of compliance monitoring is particularly important during periods of campaign operations, when resources are stretched and oversights are inevitable. This team should be responsible for all areas of toxic chemical and fuel handling and use (e.g., storage, mixing, transfer, filling, disposal; fire and health safety; warning signs, brochures, protective equipment and other commodities; etc.). This team should also be tasked with "spot" testing the workers and neighboring inhabitants for reduced cholinesterase activity or other signs of intoxication. Key populations would include those people living near storage areas, disposal sites and areas being sprayed. (Additional recommendations for more general environmental monitoring requirements are presented in Section 6.3 below.)

5.3.19 The Interministerial Pesticide Commission needs to accelerate its effort to produce a document with all the regulations and guidelines regarding the rational and safe use of (at least) the insecticides involved in the present locust control campaign. This material should be distributed to all ranks at PC and Sub PC level. This material will provide the basic information for the compliance monitoring, publicity and training programs discussed above.

The section in charge of the registration of pesticides would benefit from an IBM-compatible (XT or AT) micro-computer to rationalize their records and allow efficient retrieval of information. This unit could also keep lab records as well as field data from insecticide efficacy experiments. With this facility and the information from the registration files, a phyto-sanitary guide could be compiled, consisting of a data sheet for each agrochemical in use.

5.3.20 Extension personnel need to develop adequate extension material on pesticide safety. There appear to be no such publications available at present. Extension agents need training in the rational and safe use of pesticides. These personnel should participate in regional training courses designed for this purpose.

5.3.21 With respect to the registration of pesticides, more emphasis should be placed on the study of pesticide effects on the environment in determining whether a product can be used or not. Contamination of water is an important issue that also needs to be included in the registration data. It is recommended that the following material be made available to the Interministerial Pesticide Commission and to the Bureau of Pesticides and Registration of the Plant Protection Service:

- Regulating Pesticides. Nat. Academy of Sciences, 1980
- International Code of Conduct on the Distribution and Use of Pesticides. Rome, FAO. 1986
- Guidelines on Environmental Criteria for the Registration of Pesticides. Rome, FAO. 1985
- Guidelines for the Registration and Control of Pesticides (including a model scheme for the establishment of national organizations) Rome, FAO. 1985
- Pesticide Regulation Handbook. McKennay, Conner & Cuneo. Executive Enterprises Publ. Co., Inc.

An examination of the labeling requirements included in the current local pesticide registration procedures, suggests the necessity for some improvements. A description of the formulation and its components is required. Considerations for the protection of the environment (flora, fauna, water, soil) should also be included on the label. In addition, first aid measures must be included in the event of intoxications. The conditions for storage and suggested methods for disposal must also appear on the label. Other important items are the prescription of periods to wait before returning to a treated area, and the minimum period allowed between the last pesticide application to the crop and the harvest. For completing and updating label information, the following publication may prove useful:

Guidelines on Good Labeling Practice
for Pesticides. Rome, FAO. 1985.

In its procurement process, AID will work with U.S. manufacturers and suppliers to require that all drums be properly labelled in French and Arabic and with shipment date to enable better controls on insecticide handling and use.

Short-term visits or short courses at EPA or universities in the US, may assist in improving pesticide regulation work in Morocco. Very capable personnel, with knowledge of English, can be found in the offices of the Plant Protection Division.

6.0 Effect of Selected Insecticides on Non-Target Organisms and the Natural Environment

6.1 Original EA Comments: "The L/G PEA 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 ..., 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 ... in order to document any adverse impacts and allow for necessary mitigative action." p. 5-6.

6.2 Information Update: Although little reliable information is available on this subject, informal field research and observations indicate that program operations to date have resulted in various adverse impacts both on non-target organisms and the natural environment. The Entomologist/Environmental Specialist cites several personal and other source observations which would indicate, at least superficially, that substantive vegetative and non-target organism kills and/or degradation have occurred in program operations areas. In addition, the discussion presented in Section 5.2 above cites many examples of potential untoward environmental impacts resulting from insecticide spillages, mis-application and other potentially hazardous handling and use procedures. Of particular concern in this regard are the current conditions within the vicinity of the campaign's Aït Meloul regional base, where toxic chemical spills and contaminations over the many years of use of this facility have reached such an extent that they now threaten the economic prosperity and health of the local inhabitants of the area. This situation is even more alarming considering Aït Meloul's leadership role within the local field organization where proper examples and procedures should be set. While it is hoped that many of these impacts will prove insignificant or capable of amelioration through the various recommendations listed above, this must be properly examined and verified to assure that all such adverse impacts are kept to the absolute minimum. This goal can only be achieved through the establishment of a regular, systematic environmental research and monitoring program in campaign areas which can generate and feedback information on a continual, organized basis regarding the environmental aspects of ongoing campaign operations.

6.3 Recommendations for Future AID-Assisted Operations:

6.3.1 As a first step, the GOM must undertake without delay a thorough, yet rapid, assessment of the extent of environmental damage in and around the Aït Meloul base from toxic chemical accumulations, and its potential economic and/or health impact(s) on the neighboring local inhhabitants of the area. This assessment should provide for analysis of a representative set of soil, water, and biological (floral/faunal) samples from the Aït Melloul/Agadir vicinity for indications of any toxic chemical accumulations. Particular attention should be devoted to all local water supply sources (both surface and groundwater), and agricultural crops and livestock. This assessment should also include cholinesterase testing of a random sample of the neighboring local population. The GOM must also implement without delay any appropriate remedial and preventive measures called for through the assessment

results. In addition, it is recommended that the GOM seriously consider moving the Aït Meloul facility at the earliest opportunity to a suitable, less populated location.

6.3.2 To examine the effects of spray operations on non-target organisms, a series of research trials should be initiated in campaign areas. The Errachidia region seems the most promising location for this work to start. These trials should be small, split-block replicates to look at the effects of the various campaign insecticides on the local non-target flora and fauna. Insecticides which should be tested first are malathion, DDVP (Dichlorvos) and possibly, decis or deltamethrin. Attachment 4 provides detailed recommendations for an initial set of trials. There are two design possibilities: using 30 hectares blocks sprayed by aircraft, with 1 hectare plots; or, if aerial spraying is not feasible, using 0.25 hectare plots sprayed with a handheld, battery-powered ULV sprayer (Ulvamicron or equivalent). These trials should also include a residue sampling component. The results of these experiments should provide a baseline of data on the non-target effects of correctly applied pesticide. With such initial results in hand, it should then be possible to superpose more complex questions: what are the effects of overdosing? what is the effect of large numbers of locust carcasses? what are the long-term consequences, if any?

A parallel project would be to look at the abundance and diversity of pollinators, parasitoids and other small flying insects in the Tafilalet oasis. If sticky traps were used, it would not be very time-consuming during the height of activities, as the traps can be labelled, stored flat and examined at leisure, later in the year.

6.3.3 In addition, the PCC should organize all field personnel to systematically look for cases of possible intoxication or death in insectivorous and carnivorous vertebrates. Any specimens should be gutted; if locusts are found, they should be sun-dried and sent to Casablanca for laboratory examination (along with the head, wings, etc... of the victim to permit identification, with details of the locality, circumstances, insecticide, etc...). Particular attention should be paid to raptors (hawks and falcons), white stork (Ciconia ciconia), and the Houbara Bustard (Chlamydotis undulata). Birds are particularly important in this respect since they are noticeable, have high metabolic rates and often restricted diets, are sensitive to environmental toxins and have relatively specific habitat requirements. Such a national alert would greatly improve the chances of noticing problems, since the probability of finding anything during limited small-block trials is very low. The results of this monitoring should be compiled and reported on a regular periodic (per campaign) basis.

6.3.4 In Ouarzazate province, beehives were severely affected during last year's operations; approximately 2,500 hives were seriously damaged, out of a total estimated at 12,000. Samples of bees, honey and wax were sent to Casablanca for analysis; organophosphorus residues were found in the bees, but not in the honey or wax. Apparently, foraging bees picked up insecticide and contaminated other bees when they returned to the hive. Apiculture is extensive in this region; most families have 1-5 hives usually located in the

walls of the house. A few producers have up to 80 hives. Honey from this region is highly appreciated, the bees foraging mainly on wild flowers. In addition to their local economic value, the bees of this region are a distinct race which is of great interest to the international beekeeping community because it is a highly productive species, the bees have a large foraging radius and long mouthparts. Experiments in crossing these bees with Canadian bees are already under way, for example. Thus, these bees are a valuable resource. USAID should support further research by Moroccan scientists to determine explicitly the impact locust insecticides are having on the Saharan race of bees and what can be done to mitigate any identified problems.

6.3.5 While it is hoped that the current locust plague can be successfully eradicated during the next year's cycle of operations, a real possibility exists that the control program may require a longer term effort. In this interest, there is a need for a longer term, national environmental monitoring program to be undertaken for the duration of ongoing locust control campaign activities. Critical monitoring needs would include insecticide residue accumulations in the ambient soil, water and flora and fauna of treatment areas and in and around PC storage and handling areas. It is recommended, therefore, that each PC establish forthwith a representative set of sampling stations within each of their respective areas and proceed to collect suitable surface and groundwater, soil and floral and faunal samples on a regular, periodic basis. These samples should then be forwarded to the Casablanca Plant Protection laboratory for analysis. The results of this environmental monitoring program should be compiled into a summary, seasonal (per campaign) report for the identification of potential problem areas and appropriate mitigative measures.

7.0 Summary and Conclusions

An environmental assessment of the original Locust Control Project was duly completed in April 1988 in accordance with the Agency's 22 CFR 216 environmental procedures. This document properly addressed all salient Agency concerns regarding the environmental aspects of this project to the extent feasible given the information and experience available on this subject at that point in time. However, much has happened since the completion of this original EA, and new information and insight has been gained regarding the current status of existing local control program operations and procedures and the most appropriate mechanisms for ensuring that Agency environmental concerns are being properly addressed.

Based upon this additional information, the Update examines the status of project activities within five general categories of locust control campaign operations. These include:

- Insecticide Selection
- Efficacy of Selected Insecticides for Locust Control
- Application Methods and Equipment

- Ability of the Government of Morocco to Regulate or Control the Distribution, Storage, Use and Disposal of Insecticides

- Effect of Selected Insecticides on Non-Target Organisms and the Natural Environment

Each of these five topics is addressed in relation to the original EA findings and recommendations, new information or experience which has been gained since the original EA completion, and a list of specific recommendations to be followed for all future AID-assisted control program operations. The bulk of the new information and resultant recommendations were obtained through the work of the two AID-financed, short-term consultants (Entomologist/Environmental Monitoring Specialist and Pesticide Management and Health/Safety Specialist) recommended in the original EA. Whereas the Update generally confirms the original EA results, it also provides a greater specificity and definition to ongoing program environmental requirements as a result of the additional Morocco-specific information now available on this subject. In addition, the Update provides recommendations for certain longer-term institutional improvements in campaign environmental, health and safety operations in recognition of the possiblility that the locust plague may continue for several more years to come.

The overall thrust of the Update recommendations is that control program environmental, health and safety considerations need to be organized into a suitable local institutional framework so that they can be dealt with systematically and effectively on a long-term basis. Past experience clearly shows that the myriad of such important considerations cannot be successfully dealt with on a short-term, "ad-hoc" basis, especially during actual campaign operations. Thus, the recommendations fundamentally call for the consolidation of an Environmental/Health Safety Unit within the Moroccan campaign institutional framework to oversee the successful design and implementation of all ongoing program environmental/health safety considerations. This Unit would be assisted by USAID-financed Environmental/Health Safety advisor(s) for the duration of USG assistance to the program, and short-term consultants in specific technical areas on an as-needed basis. The Unit would have primary responsibility for all aspects of program environmental/health safety considerations, including: the design and scheduling of appropriate technical assistance, training, research and monitoring activities; specification of the types and amounts of program environmental/health safety commodities requirements; completion of all required insecticide health/safety and regulatory information, brochures and procedures; monitoring the status of implementation of program environmental/health safety recommendations; and preparation of periodic, comprehensive campaign reports covering all environmental/health safety aspects of ongoing campaign operations.

Certain other Update recommendations relate to program operational areas, such as pilot and ground crew training for improved aerial spraying effectiveness and insecticide efficacy demonstrations to promote the most cost-effective, safe and appropriate application techniques for Moroccan conditions. It is believed that most of these latter recommendations can be dealt with

adequately through the provision of short-term training assistance and a relatively modest purchase of commodities for improved target area survey, delimitation and ground/air communications.

While all of the above recommendations are important, priority attention should be devoted to the successful implementation of the myriad of program training and educational requirements indicated throughout the Update. This objective will require the coordinated assistance of specialized, short-term experts in the areas of: aerial agricultural spraying techniques; locust ground survey and target delimitation techniques for aerial operations; terrestrial treatment application techniques and safety precautions; hazardous chemicals handling, use and disposal procedures; health and medical considerations for hazardous chemicals use; and, pesticide regulatory and information procedures development. This latter assistance category will provide the bulk of the information required to implement an expanded public education and awareness promotion program to ensure that local populations are properly informed regarding locust movements and spraying operations, and necessary health and safety precautions.

In conclusion, the Update largely reconfirms the original EA findings for continued USAID involvement in Moroccan locust control operations. Moroccan campaign personnel generally seem to have a good appreciation of the potential environmental hazards associated with this type of activity. Serious problems do exist, however, in certain program areas, most notably in aerial application targeting and efficacy and the myriad of procedures being employed in insecticide handling and use. Update recommendations provide for addressing these problems through a comprehensive and systematic program of research, technical assistance, training and commodity support, as well as establishment of a campaign-wide environmental monitoring program. If these recommendations are properly carried out, it is believed that the program can be implemented in an environmentally acceptable manner commensurate with all salient Agency regulations.

8.0 Bibliography

1. AID. 1980. Agency for International Development, Environmental Procedures. U.S. Code of Federal Regulations, Title 22, Part 216.

2. 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.

3. Fischer, A J., 1988. Pesticide Safety Assessment of the Morocco Locust Control Project (Draft). USAID/Morocco. November 1988.

4. Mackay, I. 1988 Locust Operations (End of TDY Report). USAID/Morocco. December 1988.

5. Mackay, I. 1988. Effects of Locust Control on the Non-Target Fauna and Other Components of the Environment (End of TDY Report). USAID/Morocco. November 1988.

6. 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/FAO. February 1988.

9.0 Attachments

TELEGRAM

2351

UNCLASSIFIED
AID 11/04/88
DIR:CWJOHNSON
AGR:RHELLYER:NF
1.DADO:RSTRYKER, 2.ADO:REHRICH, 3.A/DDIR:KSCHOFIELD
AID-5 CHARGE

CWJ
RH RBS
RS RBS
RE RBS

AMEMBASSY RABAT
SECSTATE WASHDC, IMMEDIA
INFO AMEMBASSY KHARTOUM
AMEMBASSY ALGIERS
AMEMBASSY TUNIS
AMEMBASSY NOUAKCHOTT
AMEMBASSY DAKAR
AMEMBASSY BAMAKO
AMEMBASSY NIAMEY
AMEMBASSY ADDIS ABABA
AMEMBASSY NDJAMENA
AMEMBASSY ROME
AMEMBASSY NAIROBI
AMEMBASSY ABIDJAN
AMEMBASSY BRUSSELS
AMEMBASSY OUAGADOUGOU
AMEMBASSY PARIS

Rabat 1817

AIDAC/LOCUST

AID/W FOR OFDA/DLTF AND ANE/TR/ARD; KHARTOUM FOR CAVIN/FARNSWORTH; ABIDJAN/NAIROBI FOR REDSO; BRUSSELS FOR USEC; PARIS FOR OECD/CLUB; ROME FOR FODAG

E.O. 12356: N/A
SUBJECT: MOROCCO LOCUST CONTROL PROJECT (608-0196): SITREP 8

1. SUMMARY: SITREPS 6 AND 7 WERE TRANSMITTED ONLY TO AID/W. THIS SITREP (NO. 8) PROVIDES LOCUST COLLECTIVE WITH A RECAP OF THE SITREPS 6 AND 7 AS WELL AS UPDATE ON CURRENT LOCUST SITUATION IN MOROCCO. MESSAGE ALSO REQUESTS ACTION FROM AID/W TO EXECUTE A WAIVER FOR USE OF DECIS ON CROP LANDS. END SUMMARY.

2. AS OF OCTOBER 30, 1988, GOM REPORTED TREATING A TOTAL OF 300,000 HECTARES. DAILY TREATMENT HAS JUMPED

UNCLASSIFIED

DRAMATICALLY FROM 5000-10,000 HA PER DAY IN MID-OCTOBER TO 20,000-35,000 HA PER DAY IN LATE OCTOBER. 14 PERCENT HAS BEEN GROUND TREATMENT AND 86 PERCENT HAS BEEN TREATED BY AIR. MISSION ESTIMATES GOM PRESENTLY HAS CAPACITY (GROUND AND AIR) TO TREAT 40,000 HA PER DAY UNDER IDEAL CONDITIONS. CURRENT BREAKDOWN OF PERSONNEL AIRCRAFT, GROUND TREATMENT AND LOGISTICAL SUPPORT MATERIAL IS AS FOLLOWS:

SPECIALISTS	-	250
NON-SPECIALISTS	-	1644
TREATMENT AIRCRAFT	-	18
OBSERVATION HELICOPTERS	-	5
TREATMENT HELICOPTERS	-	8
JEEPS W/RADIOS	-	47
JEEPS W/O RADIOS	-	273
SMALL CARS	-	54
LIGHT ALL-TERRAIN TRUCKS	-	140
LIGHT ALL-TERRAIN TRUCKS - FOR TREATMENT	-	96
SMALL TRUCKS	-	7
LARGE TRUCKS	-	33
LARGE TANK TRUCKS	-	14
TANK TRAILERS	-	30
MOTOR BACK-PACK SPRAYERS	-	1630
MANUAL BACK-PACK SPRAYERS	-	196
EXHAUST NOZZELS SPRAYER	-	61

3. CLIMATIC CONDITIONS: A LARGE WEATHER FRONT MOVED SOUTHWARD THROUGH THE SOUSS-MASSA VALLEY DURING THE LATE EVENING OCTOBER 31, BRINGING COOLER TEMPERATURES AND RAIN. WINDS PUSHED LOCUST SWARMS IN THE SOUSS-MASSA VALLEY (ESTIMATED AT 20,000-30,000 HECTARES) BACK TO THE GUELMIM - BOUZAKARNE AREA (I.E. BACKSIDE OF THE ATLAS MOUNTAINS)... THIS FRONTAL SYSTEM TEMPORARILY REVERSED A VERY DANGEROUS SITUATION WHICH OCCURRED DURING THE PREVIOUS FOUR DAY PERIOD OF OCTOBER 28 TO 31 WHERE WEATHER SITUATION HAD CREATED WINDS FROM SOUTHEAST AND VERY HIGH TEMPERATURES (THE DESERT WINDS). THE STRONG HOT SOUTHEASTERLY WINDS ALLOWED MAJOR SWARMS TO MOVE OVER 250 KM IN 48 HOURS

INTO THE SOUSS-MASSA VALLEY. COOLER TEMPERATURES LASTED FOR ONLY TWO DAYS (NOVEMBER 1 AND 2). ON NOVEMBER 3, THE WEATHER AGAIN CHANGED FAVORING RAPID LOCUST MIGRATION IN NORTHERLY DIRECTION. USAID AND THE GOM BELIEVE THAT A SERIOUS THREAT WILL EXIST FOR THE NEXT THIRTY TO FORTY FIVE DAYS AS LARGE SWARMS CONTINUE TO MOVE NORTH FROM MAURITANIA AND SAHEL-WEST AFRICA. GIVEN THE LACK OF DESERT VEGETATION AND THE EVER PRESENT THREAT OF HIGH TEMPERATURES AND SOUTHEASTERLY WINDS, SWARMS (IF NOT CONTROLLED), WILL PROCEED TO THE SOUSS-MASSA VALLEY AS WELL AS TO OTHER AREAS WITH ABUNDANT VEGETATION INCLUDING MAJOR IRRIGATION ZONES.

4. THE FOLLOWING IS A RECAP OF NOVEMBER 2-4 SITUATION

- A. NOVEMBER 2: THE STORM SYSTEM CONCENTRATED LOCUSTS IN VARIOUS REGIONS. TOTAL ESTIMATED INFESTATION WAS APPROX. 13,000 HECTARES WITH MAJOR CONCENTRATION OF 7000 HECTARES IN LAAYOUNE AREA. THE GOM C-130 MADE ONE SPRAY TREATMENT OF 5000 HECTARES ON THE MORNING OF NOVEMBER 2 IN THE LAAYOUNE AREA. THE C-130 IS WORKING WITH 205 BELL HELICOPTER (WITH SPRAY SYSTEM).THE USAID TURBO THRUSH AIRCRAFT TREATED A VERY DENSE SWARM ESTIMATED AT 4000 HECTARES 60 KILOMETERS NE OF BOUZAKARNE ON NOVEMBER 1. LOCUSTS STAYED ON THE GROUND UNTIL 11:00 ALLOWING GOOD KILL RATES. OTHER AREAS, TOTALLING ABOUT 6000 HECTARES WERE BEING TREATED BY GROUND CREWS IN OUJDA, ERRACHIDIA, AND OUARZAZATE. A SECOND BELL 205 EQUIPPED WITH SPRAY SYSTEM WAS OUT OF COMMISSION WITH MECHANICAL PROBLEMS.

- B. NOVEMBER 3: GOM REPORTED THE LOW PRESSURE SYSTEM OFF COAST OF PORTUGAL IS PROVIDING IDEAL SITUATION (I.E. TEMPERATURES AND WINDS) FOR NORTHERLY MOVEMENT OF LOCUSTS. GOM STATED TOTAL INFESTATION LEVEL AT 42,500 HA OF WHICH 37,651 HA WERE TREATED. LOCATIONS WERE AS FOLLOWS:

- 22,000 HA OUARZAZATE
- 6,220 HA AIT MELLOUL (IN THE SOUSS-MASSA VALLEY, 10 KMS FROM AGADIR)
- 6,635 HA TATA

- - 3,060 HA ERRACHIDIA
- - 2,700 HA BOUARFA
- - 1,155 HA OUJDA
- - 800 HA GUELMIM
- - SWARMS IN THE SOUSS-MASSA VALLEY WERE TREATED WITH AIRCRAFT AND GROUND TREATMENTS USING KARATE AND DECIS. THE GOM PREFERS TO USE THESE PESTICIDES IN AGRICULTURAL REGIONS. THE GOM PREPOSITIONED TWO P.A. 25 AIRCRAFT IN MARRAKECH. ONE P.A. 25 CRASHED (PILOT UNHARMED) ON NOVEMBER 3 DUE TO HIGH WINDS IN MOUNTAIN AREA.

- C. NOVEMBER 4: AT 9:00, GOM REPORTED A TOTAL 75,487 HA INFESTATION WITH 50,765 HA IN THE GUELMIM AREA, 17,681 IN TATA AREA, 6,420 HA IN THE OUARZAZATE AREA AND 621 HA IN THE OUJDA AREA. AT 11:00, APPROXIMATELY 100,000 HA OF ADDITIONAL SWARMS WERE CONFIRMED MOVING THROUGH THE SAHARA. THIS REPRESENTS MAJOR NEW SWARM MOVEMENT INTO THE REGION FROM MAURITANIA. USAID TURBO THRUSH PILOTS, WHO HAD BEEN SCHEDULED FOR A DAY OFF IN AGADIR, WERE IMMEDIATELY SENT BY HELICOPTER BACK TO GUELMIM IN THE EARLY MORNING AND HAVE BEGUN TREATMENT OF A 6000 HA BLOCK.

5. WAIVER REQUEST FOR DELTA-METHRINE (DECIS): ON OCTOBER 28, 1988, GOM BEGAN TREATMENT OF SWARMS NEAR CHICHAOUA 50 KM WEST OF MARRAKECH AND NORTH OF THE ATLAS MOUNTAINS. THESE SWARMS WERE TREATED WITH DELTA-METHRINE (DECIS) USING EXHAUST NOZZELS MOUNTED ON LAND ROVERS. THE CROP PROTECTION PERSONNEL REPORTED THAT DECIS IS GOM INSECTICIDE OF CHOICE FOR USE ON AGRICULTURAL CROPLANDS. PRESENTLY THEY HAVE 10,000 LITERS ON HAND AND 100,000 LITERS ON ORDER. MISSION ANTICIPATES THAT USAID FINANCED AIRCRAFT MAY BE CALLED UPON TO APPLY DECIS. MISSION REQUEST AID/W PREPARE AND EXECUTE WAIVER TO ALLOW FOR USE OF DECIS IN USAID AICRAFT. HAWES**

ACTION AID2 INFO: DCM ECON, AGR

OFFICIAL FILE

LOC: 413 879
11 DEC 88 1022
CN: 41802
CHRG: AID
DIST: AID

608-0196

VZCZCRA0009EHU410
PP RUFHRA
DE RUEHC #0174 346061
ZNR UUUUU ZZH
P R 110012Z DEC 88
FM SECSTATE WASHDC
TO RUFHRA/AMEMBASSY RABAT PRIORITY 8235
INFO RUEHAS/AMEMBASSY ALGIERS 2613
RUEHTU/AMEMBASSY TUNIS 2788
RUEHAB/AMEMBASSY KHARTOUM 0193
RUEHDK/AMEMBASSY DAKAR 3865
RUTANA/AMEMBASSY NOUAKCHOTT 6349
BT
UNCLAS STATE 400174

ACTION: AGR
DUE DATE: 12/14
INFO: DIR DIR2 PROG
AGCONS OFD CHRON-RF

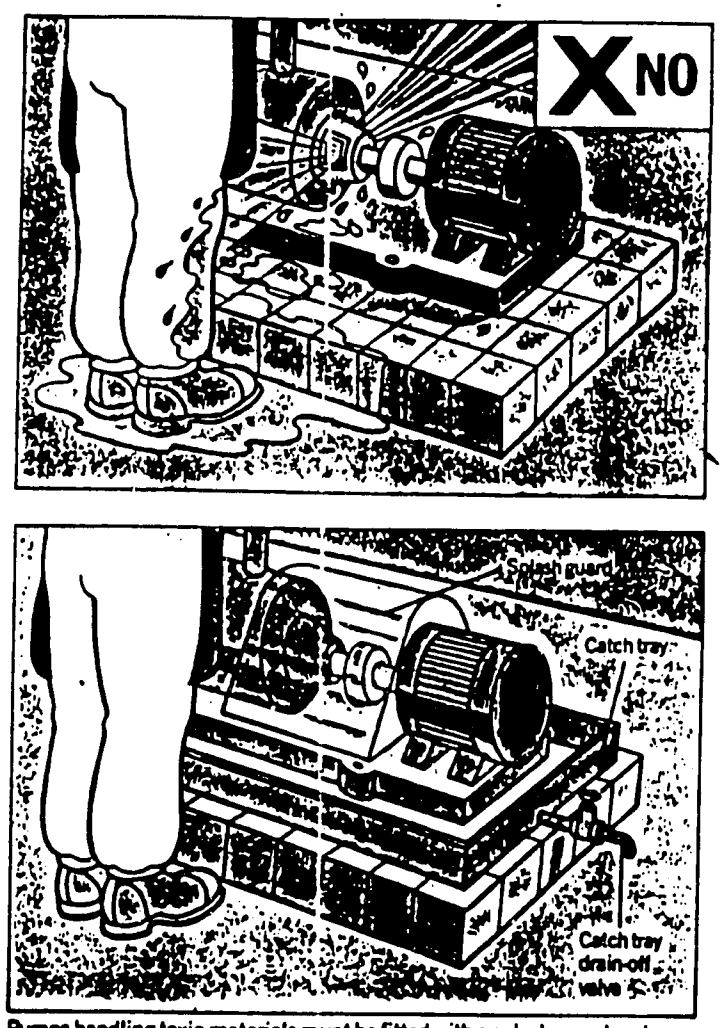
AIDAC LOCUST RABAT FOR HELLYER/KITTS

E.O. 12356: N/A
TAGS:
SUBJECT: LOCUSTS - APPROVAL OF DECIS WAIVER

1. ON DECEMBER 8, 1988, THE ADMINISTRATOR SIGNED A DOCUMENT WAIVING REGULATION 16 PESTICIDE PROCEDURES FOR THE USE OF DECIS (A SYNTHETIC PYRETHROID) IN THE LOCUST CONTROL PROGRAM IN THE KINGDOM OF MOROCCO.

2. THE WAIVER MAKES REFERENCE TO THE PROGRAMMATIC ENVIRONMENTAL ASSESSMENT (PEA) WHICH DISCUSSED SYNTHETIC PYRETHROIDS GENERALLY, WHILE ADDRESSING THE USE OF TWO SPECIFIC SYNTHETIC PYRETHROIDS FOR LOCUST CONTROL, LAMBDA-CYHALOTHRIN AND TRALOMETHRIN. IN PROVIDING GUIDANCE ON SYNTHETIC PYRETHROIDS, THE PEA CAUTIONED THAT THESE CHEMICALS ARE HIGHLY TOXIC TO AQUATIC ORGANISMS. THE WAIVER CITES THE PEA CAUTION, AS WELL AS THE SPECIFIC GUIDANCE THAT A BUFFER ZONE OF 500 METERS BE OBSERVED WHEN APPLYING PESTICIDES BY AIR NEAR AQUATIC ZONES.

3. FULL TEXT OF WAIVER BEING POUCHED TO MISSION.
SHULTZ
BT
#0174



Pumps handling toxic materials *must* be fitted with a splash guard and catch tray.

(N.B.: This attachment also serves as an excellent example of the type of visual training aids which should be used extensively throughout all recommended staff training activities.)

Pesticide Management Training Technical Topics

1. **FAO Code of Conduct**

   Introduction to the FAO International Code of Conduct on the Distribution and Use of Pesticides

2. **Introduction to Pest and Pesticide Management**

   Overview defining the term pest, a general description of pest categories and the types of damage each causes.

   Explanation of "pesticide management" as including all aspects from manufacture/formulation through distribution, retail, application and residue disposal.

3. **Pest Control Methods**

   Explanation and description of various general control categories (e.g. prevention, cultural, physical/mechanical, biological, chemical).

4. **IPM**

   Definition of Integrated Pest Management including application accross and within various pest management disciplines. Suggestion of need for econonic and environmentally sound approach to pest management.

5. **Pesticides**

   Focus on types of pesticides, and categorization based on chemistry and target pests. Discussion of characteristics of each group and practical implications for their use. Also discussion of formulation, packaging, label information, etc.

6. **Safety**

   Focus on precautions to take when handling pesticides in transport, storage, mixing, application, and residue and container disposal. Recognition of poisoning symptoms and first aid procedures.

7. **Application Equipment**

   Description and demonstration of various pesticide application equipment including proper use and maintenance.

8. **Equipment Calibration**

   Description and exercises in determining total volume of spray solution applied to any area to be sprayed.

9. **Dose Calculation**

   Description and exercises in determining the amount of formulated product needed in the spray solution.

10. Extension Resources and Methods

Discussion of regional, national and international public and private organizations that may serve as informational resources Discussion and demonstration of various methods for communicating pesticide management information to farmers.

11. Pesticide Legislation/Regulation

Discussion of government control schemes for pesticide use at national and regional levels.

Includes suggestion for compliance with FAO guidelines and International Code of Conduct for the Distribution and Use of Pesticides.

topics.doc 08/15/88

ANNEX. Outline and protocol for a pilot experiment to assess the effects of locust spraying on the non-target arthropod fauna in Morocco

Definitions

Study Sites: Sites should be in the general areas undergoing spraying, should be ecologically representative and preferably not infested with desert locusts. One site should be located in the Oued Draa seasonal flood zone and another in the arid steppe zone west of Errachidia. The exact sites for the experiments should be chosen by the principal investigator in January, from the range of possible sites visited.

Experimental unit: Split block

Replication: 1 malathion sub-block, 1 DDVP sub-block, 1 control sub-block, matched as closely as possible for physical and biological characteristics.

Experimental design: Split block, three replicates (9 sample plots). See below for details.

Sampling methods: Ground arthropods will be sampled using pitfall traps: buckets inserted flush with the ground surface that will be emptied daily. The traps will have square, white painted covers (30 x 30 cm). Small flying insects will be monitored using TRECE sticky traps mounted on 1 meter poles. Residues will be sampled on soil, water and vegetation (annual and perennial). Other sampling methods can be added if time is available.

Outline

Survey: Identify suitable homogenous sites of approximately 100 hectares. Map area and inform local authorities of site locations.

Delimit areas: Define blocks, sample plots and mark with flags on stakes.

For aerial spraying spraying delimit two 30 hectare blocks for treatment and a 30 hectare control block which should be upwind of treated areas. There should be at least 500 meter wide buffer zones between treated areas.

For spraying with a handheld, battery-powered ULV sprayer (ULVA micron or equivalent), delimit 1 hectare plots.

Description of sites: A detailed description of physical characteristics, soil, vegetation, animal and/or human use etc... Begin daily recording of temperature (maximum/minimum), humidity, rainfall, condition of sky.

Prespray activities: Take samples of vegetation, soil and water for residue analysis (follow whatever protocol is requested by Plant Protection Casablanca laboratory or researchers at I.A.V. Hassan II, Rabat). Flag blocks for spraying with 1x2 meter white flags on 3 meter high poles. Install pitfall traps, stakes for sticky traps. 10 pitfall traps should be installed at 15 meter intervals along the vertexes of a triangle i.e. 3 radial 45 meter transects. 9 sticky trap sites should be assigned randowly. Unabiguously mark any other other sampling sites (anthills, bushes, etc.). Check aircraft or other equipment calibration on a separate check plot. Begin separate test to establish best interval for changing sticky traps (1 day, 2 days etc.).

When all this has been done, decide on date of spraying and then begin prespray data collection (5 days before, 1 day before).

Aerial Spraying: Spray units of 30 hectares (1000 x 300 meters) with each chemical (malathion and DDVP) at rates currently used. Malathion 96% ULV: 0.75 liters/ha. (885 grams active ingredient/ha). DDVP (Dichlorvos) 20%: liter/ha (200 g a.i. /ha). Control pilot should be upwind of spray plots. Staggered plots with 500 meter buffer zones. A line of spray cards perpendicular to the swath to monitor deposit (150 meter line at 5 meter intervals, horizontal and vertical cards at height of 20 cm. Vertical cards should be less that 6 mm wide. Minimise drift, VMD 80-120 um. Aircraft height should be 3-4 meters, no wind.

Ground spraying: Spray 1 hectare plots with Ulvamicron (fresh batteries). Monitor deposit with cards. The same cautions apply, as with aerial application.

Immediate Postspray: Qualitative assessment of any mortality; collect cadavers for reference at 1, 12 and 24 hours. Install sticky traps and check pitfall covers.

Sampling: Three replicates. 9 one hectare plots, each with 10 pitfall traps and 9 sticky traps located in the central part of sprayed areas to minimise any edge effects.

Sampling frequency. Sample intervals of -5, -1, 0, 1, 5, 10, 15 days post-spray. Pitfall traps emptied daily (early morning).

Data analysis. Population counts, enumerated by taxa (taxonomic level to be decided). Data will be interpreted using appropriate linear models (ANOVA, comparison of means).

Supplementary activities: Qualitative observations on other taxa, including vertebrates. Taxonomic inventory of study area. General insect collecting in adjacent matched sites, including light trapping, beating, malaise trap, for baseline faunal information. Investigate other possible methods of monitoring e.g. blacklight transects for scorpions, constant time counts of bees visiting bushes, robber fly transects, etc...

Discussion: These activities will probably require the full time participation of at least two people per site. Time required to collect the data is the constraint. I estimate at least a week to delimit areas, install traps, stakes, etc. Approximately two weeks for sampling and a week for analysis and write-up (longer if taxonomic work is needed). It should be possible to spray both chemicals in one morning (30 ha each).

The ground fauna will be sampled with the pitfall traps whilst the sticky traps will catch small flying insects. Larger flying insects are not being sampled. Neither sweep-netting nor light trapping are valid quantitative techniques and are not recommended for a study of this sort. It might be possible to identify indicator species to use as monitors: they should ideally be easily located, identifiable, regularly distributed and numerous enough to provide a valid sample. I predict that whatever sampling is done, the results will prove to be highly variable in space and time. This problem can only be solved by much more intensive sampling.

Materials List For Small-Block Trials

Maps, large blank sheets for mapping site
Marking stakes, 60 cm long, and paint
Flag poles (3m) and 1 by 2 meter white flags (20)
Compass or 90 degree prisun
Measuring tape or rope (30 meters)
Notebooks, pens, pencils
Recording forms and clipboards
Field tags, marking pens
Spray cards (3 packets)
Spray card holders, 30 cm wire (45)
Pliers and roll of wire
Sticky traps (300)
Stakes, 1 meter painted (100)
Pitfalls: 100 plastic buckets (20 cm by 18 cm 0)
100 covers, painted plywood 30 x 30 cm
nails for feet
Picks and shovels
Plastic bags (500)
Alcohol, ethanol 95% (2 liters)
Measuring cylinder 500 ml
Rubber gloves
Bucket
Collecting light
Insect nets
Killing bottles
Insect pins and boxes
Flashlights, batteries
Maximum-minimum thermometer
Psychrometer
Rainganges
Handheld windmeter

2 hand click counters
240 gallon ice-chests (transporting residue samples)
200 20 x 30 on plastic bags (samples)

2 20 liter water bidons
2 Ulvamicron sprayers
4 sets batteries for sprayer

ANNEX D

TECHNICAL ANALYSIS

ANNEX D

TECHNICAL ANALYSIS UPDATE

1. Pattern of Locust Invasions in Morocco and its Relationship to Control Strategies

Based on the experience gained in Morocco during the October 1987 - June 1988 campaign and the current campaign which began in October 1988, as well as knowledge of the regional locust migratory cycle, it is possible to generalize about characteristics of the locust invasions into Morocco. For example, entry points in relation to time of year, swarm movement within Morocco in relation to seasonal climatic conditions, the effect of the Atlas mountains on swarm movement, and the nature of the biological cycle throughout the invasion period are factors that influence control strategy in much the same way for each campaign.

Although the magnitude of invasions into Morocco may vary (i.e., 10 times larger during the current campaign than during the first campaign (October 1987 - June 1988)), the pattern of invasion for each campaign is similar and provide a basis for developing and implementing control strategies. Moreover, the unique nature of these predictable patterns of invasion in Morocco provide an opportunity for applying a strategy that not only protects Moroccan agriculture but also may reduce the overall global locust population returning to summer breeding zones in the Sahel.

During the early invasion period (October - November), locust swarms enter Morocco primarily through the Mauritanian corridor. Swarms are initially small but increase in size and intensity fairly rapidly. During this period, locusts are pink, immature adults, and are especially voracious. They have traversed a region through Mauritania which is dry and lacking vegetation so that by the time they enter Morocco, they are hungry and in search of green vegetation. Most of the region behind the Atlas mountains is limited in vegetation at this time. In addition, temperatures are likely to be warm, even in the Atlas mountains. Thus, there is a high potential at this time for swarms to cross the Atlas or to bypass the mountains via the coast and enter directly into the Souss Valley where ample irrigated crops exist.

In late November and December, the invading swarms markedly increase in size and also begin entering from Algeria, affecting a broader front in Morocco (from Errachidia to Guelimin). By the end of December, locust swarms are entering Morocco from both the Mauritanian corridor and across a wide stretch of the Algerian border which gives an invasion front affecting a transect from Tan-Tan all the way to Oujda (some 1500 km). Many of the locusts entering from the Mauritanian corridor also begin moving northeasterly behind the Atlas mountains toward the Oujda region. Swarms are pink, immature adults during this period.

By December, the first rains have usually fallen behind the Atlas mountains, the southern Sahara and in northwestern Mauritania. This permits vegetation to emerge in a broad area and can create favorable habitat for breeding particularly in the northwestern regions of Mauritania and the southern Sahara. Temperatures also tend to remain warmer in this region as compared to the Anti-Atlas where temperatures tend to drop by December. Lower temperature and snow capped mountains increasingly create an effective barrier against further locust migrations to the north. However, it must be noted that temperatures can be variable in December even in the mountains and hence, if several days of warm weather persist, locust activity can increase rapidly and mountain crossings can still occur. Nevertheless, the importance of the Atlas mountains as an effective natural barrier cannot be overemphasized. Locust swarms which move into the mountains, principally along smaller river valleys pose greater difficulty for survey and treatment because of the more variable terrain and micro-climatic conditions.

By the middle of January, cool temperatures are the norm and rains are more frequent. In addition, the vegetation which has been produced south of the Atlas mountains provides alternative feeding areas for locusts. By this time, the threat to migration into the Souss and/or other regions north of the Atlas is much less. At the same time, locusts are reaching the yellow phase (sexually mature adults) and are ready to breed. As a consequence, the locusts begin to look for suitable breeding areas rather than for vegetation.

Breeding begins in northwest Mauritania during late December and January. The resulting new generation gives rise to swarms by March which then migrate northerly into Morocco. From March through June, heavy invasions into Morocco and southern Algeria occur. These swarms continue their migration across the Maghreb. By April this generation reaches the yellow phase (sexually mature) and begins searching for breeding areas. Breeding will occur in any favorable habitat such as broad valleys and small wadis in the mountains. Hopper bands follow during May. A high proportion of locusts in Morocco are in the hopper band phase during May. They will attain swarming capability by end of May or early June and begin migration southward to the Sahel. By the end of June, locust swarms leave Morocco.

2. Survey and Communication

The GOM Central Command Post (PCC) maintains information links with other affected countries in order to obtain data on population build up, breeding areas and migratory movements. In addition, the PCC receives information updates from FAO and particularly from USAID, through the USAID locust collective (sitreps). This information provides a basis for predicting when locust populations are likely to invade Morocco and the general magnitude the invasions. Although this regional communication network has steadily improved, over the last year, primarily as a result of USAID missions reporting sitreps, there is still often a lack of information concerning critical areas, such as in northern Mauritania. Lack of information is usually a result of either political strife or the lack of resources to undertake prospection in critical regions. Although FAO has a major role in this regard, the ability of FAO to undertake prospection and to report information on a timely basis has been less than adequate.

Within Morocco, GOM has organized itself nationally into a system of command posts (PCs) throughout the affected region (see institutional analysis). Ground survey teams are assigned to PCs and sub-PCs for the purpose of prospection and swarm marking. In addition, the military border posts (approximately 5 km a part) report sightings of invading swarms to the respective PC in their region. Provincial governors offices, ORMVA's, DPA's and the local population (farmers) are also now very aware of the locust problem affecting their region and report sightings to the PCs. The GOM also utilizes helicopters for aerial prospection.

The GOM has augmented its ground based survey to about 200 teams assigned full time to the locust program. These teams have the responsibility for prospection and marking swarms for aerial treatment. Survey teams are assigned to PCs and most are provided with vehicles, and some with radios and marking equipment. As swarms are sighted and reported on a daily basis, survey teams are dispatched to the area to determine size, density, biological activity and location coordinates. Flying swarms are tracked until they settle in the evening. This information is communicated by radio, by telephone, or by physically returning to a communication point (if no radios are available), or to the respective PC in the region. The PC synthesizes all information including that from other survey teams and then transmits information to Ait Melloul and to the PCC in Rabat. Decisions are made prior to the following morning relative to what swarms will be treated by available aircraft or ground treatment.

When locusts approach the breeding phase, special attention by survey teams is given to locating potential egg laying sites. Actual breeding locations and egg laying sites are recorded. This information along with climatic data is gathered and recorded on grid maps. The grid maps are used to determine highest probable areas for hopper emergence. This is an especially important technique since it is virtually impossible to prospect all possible areas especially in mountainous areas.

Both the Ait Melloul center and the PCC in Rabat play critical roles in coordinating the overall strategy for surveillance, prospection and treatment marking. If it is determined that certain provinces are more likely to be heavily infested than others, survey teams and material can be redeployed.

The GOM has significantly expanded the survey, prospection and marking capability since the first campaign and some training and improved logistical capability has been given to these teams. However, there are several areas which still need to be improved. One difficulty relates to the problem of tracking flying swarms. Survey teams attempt to follow swarms until they settle. However, this is not always possible because of terrain or the inability to keep up with the swarms by vehicle. Thus, lost swarms are often sighted again and recounted, leading to over-estimation of the number of swarms. It is also difficult to estimate accurately the size of flying swarms. Survey is more difficult in mountainous regions where vehicles cannot penetrate. Survey capabilities will be enhanced by providing additional portable radios, to all survey crews and by training them in how to utilize them. In addition, training to improve survey and prospection techniques,

marking swarms for treatment, and standardized information reporting (resting swarms) will increase the accuracy of overall target selection and treatment. Additional helicopter prospection may also be useful in order to track major swarms. The project will provide selected commodities, technical assistance and training of trainers in order to improve the survey capability.

3. Insecticides

For purposes of planning and overall readiness, the GOM attempts to maintain a two million liter stock of prepositioned insecticides at least three months in advance of anticipated invasion periods. With ULV application, this quantity would treat approximately two million hectares. This quantity could be utilized fairly rapidly during peak invasion periods. For example, the GOM is attempting to achieve a control capacity of 100,000 hectares per day (see control capacity below). A sustained level of treatment on a daily basis would require nearly 100,000 liters of insecticide per day and thus the stock supply would be consumed in 20 days. As stocks are depleted, the GOM attempts to replenish the 2,000,000 liter stock supply in order to keep a reserve on hand. Obviously, this becomes difficult during peak invasion periods because the consumption rate is high. Insecticides are furnished by donors and by the GOM with the bulk now being purchased with GOM resources. USAID believes this prepositioning strategy is sound and will assist the GOM with procurement of selected pesticides for prepositioning purposes (normally 400,000 liters per campaign).

Thus far, USAID has supplied only malathion. However, USAID anticipates that alternative EPA approved insecticides may be provided under the project in the future. Alternatives to malathion will be based upon their efficacy under anticipated conditions and availability. For example, if it became necessary to treat in areas where agricultural crops are predominant, alternative pesticides such as Decis may be preferable.

One of the principle constraints to insecticide choice has been their availability on the world market in large quantities. Most pesticides except malathion do not appear to be available on the world market in the quantities needed. The two other pesticides which have been most utilized in Morocco are Fenithrothion and DDVP. Although USAID operations can utilize Fenithrothion, they are restricted from utilizing DDVP. The GOM has tended to utilize DDVP because of its market availability and because of its higher toxicity. Fenithrothion has been available from European suppliers. USAID will not utilize non U.S. Government approved insecticides such as DDPV and moreover, will discourage the GOM from using such insecticides. The GOM has indicated its intention to utilize DDVP in the more remote treatment regions and its interest in knowing more about U.S. findings and restrictions on its use.

A number of recommendations are given in the environmental analyses, relative to testing of alternative pesticides, improving pesticide handling, storage and disposal systems, and increasing treatment efficiency. These recommendations will be implemented under the project. USAID will provide technical assistance, selected commodities and training in this regard.

4. Control Strategy and Treatment Capacity

The principal objective of the GOM strategy has been and continues to be protection of crops in major agriculture regions such as the Souss valley and areas north of the Atlas mountains. However, the GOM is acutely aware of the regional migratory nature of the desert locust and the potential impact of an uncontrolled plague on all affected countries. Given the fact that a major portion of the total desert locust population migrates into Morocco between October and June, and concentrates in the region south of the Atlas, the GOM is also committed to a strategy of reducing the overall population (breaking the plague) which would otherwise return to the Sahelian summer breeding regions. For the second part of this strategy to have a significant impact, it is important that a similar strategy be adopted by affected countries and the international community in order to treat other critical regions (such as the Red Sea coast). Although it can be argued that a GOM strategy that contributes to breaking the plague can not succeed because effective treatment in other critical regions of Africa will not be undertaken, the argument has little relevance to how Morocco conducts actual control measures. In other words, the strategy in Morocco would basically be the same, regardless of whether the plague can be broken. The two part strategy for Morocco simply represents recognition of a unique set of conditions that permit implementation of a control program for crop protection and breaking the locust plague at the same time.

The strategy consists of treating locusts behind (south) of the Atlas and Anti-Atlas mountains where they invade and concentrate. The Atlas mountains provide an effective barrier and permit treatment to take place in the most unproductive (economically) and lowest populated (human and livestock) areas of Morocco. This region also permits the GOM to develop and implement a realistic treatment strategy taking into account tactical considerations. For example, invading swarms normally spend several days to several weeks in this region, depending on climatic factors, before they reach the Atlas mountains. This allows sufficient time for prospection followed by treatment to be conducted. Once swarms reach the mountains, prospection and treatment becomes much more difficult because of terrain. Moreover, if the concentrating effect of swarms is allowed to continue as they move northerly toward the Souss valley, it then becomes necessary to deploy greater numbers of aircraft in more highly populated areas and in a shorter treatment time frame.

The GOM utilizes both ground and aerial treatment on resting swarms in the early morning. Ground treatment is utilized for swarms of 100 hectares or less and in areas unaccessible to aircraft such as small mountain valleys. Aerial treatment also is employed on resting swarms in early morning hours. The type of aircraft is related to size of swarm and in some cases distance to target.

During the early invasion phase (October - December), it is critical to treat invading, voracious swarms in order to prevent their migration into the Souss valley. Medium size aircraft (single engine turbo-thrush) are normally adequate during the early period of invasion but larger aircraft (four engine DC-7) are also likely to be needed by November and December depending on size and frequency of swarms (swarm sizes of 5,000 to 10,000 hectares have been common during the November - December 1988 timeframe).

During January - February, the threat of migration across the Atlas mountains is reduced because of colder weather and because more swarms are settling in northwest Mauritania and the western Sahara for breeding. Nevertheless, it is important to maintain adequate treatment capability in order to reduce the potential population which will breed. Normally, medium size aircraft are appropriate both on a stand-by basis and as needed to treat swarms. It is also important to maintain an alert capability during this timeframe as the situation is somewhat uncertain depending on unknown swarms that may migrate from Mauritania and Algeria.

During the March through June period, an active and high level treatment capability is necessary. Moreover, control must be directed to both adult swarms as well as emerging hoppers. Both medium size and large aircraft should be anticipated.

Effective hopper control depends heavily on accurate survey. If hopper infestation occurs in vegetated areas, then aircraft and ground sprayers can use both contact pesticides and ingestion pesticides (stomach poison) such as carbaryl, the latter which would be used in barrier strips. However, the experience in 1988, showed that hoppers emerged during a period when vegetation was drying up. Hence, carbaryl was not effective. Since several pesticides may be of value, aircraft spray systems must be able to change calibration quickly or alternatively, specified aircraft must be dedicated to certain pesticides.

Treatment priority is given to larger swarms, breeding locusts, and to hoppers. The greatest difficulty encountered thus far has been effective control of hoppers. They are difficult to prospect, especially if egglaying takes place in the numerous mountain valleys, and hence difficult to treat.

So far, the current strategy has blocked locust swarms from crossing the Atlas mountains (except for several minor swarms in the fall of 1988) and entering into important crop production areas. Nevertheless, the GOM and USAID have begun to consider how the strategy would need to be altered if, in fact, major migration across the Atlas occurred. The GOM has already begun to equip three new PCs (Marrakech, Kenifra, Safi, Essaouira and Missour) for possible activation should the need arise. These PCs are linked to the central PCC institutional structure, have limited pesticides stocks (5,000 - 10,000 liters), one small aircraft at their disposal, and a number of ground base spray equipment. If the situation warrants, the GOM will augment resources (aircraft, pesticides and logistics) at these PCs. Additional PCs also would be developed as needed.

It is not possible at this time to predict where and how many swarms might penetrate into regions north of the Atlas mountains. The GOM would give highest priority to protecting the Souss valley and other irrigated areas such as Beni Mellal. Treatment would consist of both aerial and ground based spray equipment. It is likely that greater involvement by farmers themselves can be anticipated, utilizing backpack sprayers. Alternative pesticides such as Decis or possibly bran-baited pesticides would be employed. USAID and the GOM will further assess the preferred strategy for possible intervention north of the Atlas mountains and determine what, if anything, the project would provide to augment capacity.

The current GOM strategy is to increase its overall aerial treatment capability to 100,000 hectares per day. Currently, the capacity is about 83,000 hectares per day. This consists of about 23,000 hectares capacity provided by GOM aircraft (one C-130 and 11 small aircraft). In addition, the GOM currently has 21 small aircraft on lease providing about 20,000 hectares per day capacity. There are approximately 14 donor aircraft providing about 37,000 hectares per day. Of the latter, USAID is supplying about 25,000 hectare per day capacity with two turbo thrush and two DC-7's. Unfortunately, the aerial treatment capacity is extremely fluid as the GOM cannot rely on most donors for long term commitment (except USAID) nor has the GOM been able to lease aircraft with certainty. For example, 15 turbo thrush aircraft currently under lease, will not be available after March 1989.

Ground treatment capacity consists of utilizing backpack sprayers and truck mounted foggers. Thus far, actual ground treatment has been about 1000 hectares per day but could be increased if needed with no additional procurement.

ANNEX E

REDELEGATION OF AUTHORITY CABLE

CO RUFHRA
DE RUEHC #8900 3160148
ZNR UUUUU ZZH
C 110148Z NOV 88
FM SECSTATE WASHDC
TO AMEMBASSY RABAT IMMEDIATE 77(
BT
UNCLAS STATE 368900

14 NOV 88
CN: 35068
CHRG: AID
DIST: AIDA

60. 136

AIDAC

E.O. 12356: N/A
TAGS:
SUBJECT: PROPOSED LOCUST CONTROL PROJECT AMENDMENT

AG
11/1

1. WE APPRECIATE UPDATE ON THE LOCUST SITUATION AND CURRENT THINKING OF GOM WITH REGARD TO PROPOSED GREEN (STRIKE) FORCE. CONTRACT ACTIONS ARE MOVING FORWARD ON DC-7 LEASING FOLLOWING EXHAUSTION OF OFDA FUNDING. WE ANTICIPATE AID FUNDED CONTRACT TO BE IN PLACE TO MAINTAIN CONTINUITY OF SPRAYING SERVICES AS NEEDED.

DIR-ADDIR-
PROG-AG-Cons-Cont-
Chem-RF

2. PROJECT AMENDMENT: THE MISSION HAS DELEGATED AUTHORITY TO AMEND THE PROJECT UP TO US DOLS 30.0 MILLION. THEREFORE, THE PROPOSED US DOLS 6.0 MILLION ADD ON CAN BE AUTHORIZED BY USAID DIRECTOR. THE ACTUAL OBLIGATION OF FUNDS HOWEVER, CANNOT BE SIGNED UNTIL CN EXPIRATION PERIOD EXPIRES AND ALLOTMENT OF FUNDS IS APPROVED BY OMB. IN RESPONSE TO REFTEL PARA 3B REQUEST FOR CN GUIDANCE, WE WILL NEED A REVISED PROJECT BUDGET TO INCLUDE INPUTS/OUTPUTS FOR THE PROJECT ACTIVITY SHEET AND ANY OTHER INFORMATION PERTAINING TO SUBSTANTIVE CHANGE IN PROJECT DESIGN. WE HAVE BEEN ADVISED THAT PROCESSING THE CN PRESENTS NO PROBLEM AT THIS TIME AND WE HAVE RECEIVED ASSURANCES FROM PPC THAT OMB WILL PROMPTLY APPROVE THE NECESSARY ALLOTMENT OF FUNDS.

3. LEASE VS. BUY OF TURBO-TERBUSE TYPE AIRCRAFT: WE HAVE REQUESTED ADVICE FROM OFDA EXPERTS ON THIS ISSUE. ALTHOUGH IT IS CHEAPER TO BUY IF AIRCRAFTS ARE TO BE USED FOR A PERIOD EXCEEDING THREE YEARS, THE ADMINISTRATIVE AND MANAGEMENT REQUIREMENTS RELATED TO PERSONNEL PARTS, HANGER RENTAL, FUEL, LUBRICATION OIL, IN-COUNTRY PERMITS, CERTIFICATION, HOUSING, SCHEDULING, LIABILITY INSURANCE, TOOLS AND SPECIAL EQUIPMENT MAKES LEASING THE PREFERRED OPTION. THUS THE RECOMMENDATION OF USDA APHIS/FOREST SERVICE IS TO LEASE (AND NOT TO BUY) AIRCRAFT. BOTH AIRTRACTOR AND TERUSE TURBO AIRCRAFT ARE RECOMMENDED. PRICE AND DELIVERY TIME SHOULD BE THE SELECTION CRITERIA. WHITEHEAD
BT
#8900

NNNN

03

ANNEX F

PROCUREMENT SOURCE/ORIGIN WAIVER

Procurement Source/Origin Waiver
Waiver Control No. 608-89-03

ACTION MEMORANDUM FOR THE MISSION DIRECTOR

From: Rollo Ehrich, Agricultural Development Officer

Subject: Justification of Proprietary Procurement and Request for Procurement Source and Origin Waiver for the procurement of Cholinesterase Monitoring Tes Kits and the incidental services of a Training Consultant under the Morocco Locust Control Project (608-0196).

PROBLEM

The implementation of the Morocco Locust Control Project, as amended by PP supplement No. 1, requires the procurement of 20 additional Cholinesterase Monitoring Test Kits, together with the services of a consultant to train GOM technicians in the use of these kits. The kits are used to monitor whole blood cholinesterase levels in workers that might be exposed to pesticides in the course of the GOM locust control program. These kits are only available from a single manufacturer in Great Britain. In order to allow such procurement, you are requested to grant a source/origin waiver from geographic Code 000 (U.S. only) to Geographic Code 935 (special free world). A similar waiver was issued in June, 1988, in connection with procurement of 15 kits under the original Project.

SPECIFIC INFORMATION

(a) Cooperating Country :	Morocco
(b) Authorizing Document :	Project Agreement No. 608-0196
(c) Project :	Morocco Locust Control Project
(d) Nature of Funding :	Economic Support Funds
(e) Description of Goods:	Twenty (20) Cholinesterase Monitoring Test Kits and the services of a consultant to instruct GOM technicians in the use of these kits.
(f) Approximate Value :	$ 37,500
(g) Probable Source :	Great Britain
(h) Probable Origin :	Great Britain

DISCUSSION AND JUSTIFICATION

A current infestation of desert locusts is threatening significant loss of agricultural production in Morocco. The purpose of the Morocco Locust Control Project (608-0196) is to assist the GOM in controlling the desert locust. Under this Project, USAID is providing technical assistance, the use of spray aircraft, logistical equipment, pesticides, training, and miscellaneous commodities, including Cholinesterase Monitoring Test Kits. Project Paper Supplement No. One will authorize funding for three campaigns through June 1991.

Under the Project Paper Supplement, USAID will provide Government of Morocco (GOM) Ministry of Public Health (MOPH) with 20 additional Cholinesterase Monitoring Test Kits, together with technical assistance in the use of these kits. These kits will be employed to monitor whole blood cholinesterase levels in workers exposed to cholinesterase-inhibiting insecticides (e.g. malathion, fenitrothion, and carbaryl) in the course of the GOM locust control program. The test kit is designed for use under field conditions by technicians with minimal training. The use of this kit will allow the MOPH screen workers for cumulative pesticide intoxication and thus prevent potential cases of chronic pesticide poisoning. The cost of the test kits is approximately $675 each. Together with miscellaneous equipment (e.g. reagents and test tubes), the total cost of the equipment to be procured will be approximately $25,000. There is only one type of Cholinesterase Monitoring Test Kit that is designed for use under field conditions by technicians with minimal training. This type is made by only one company, Tintometer Limited, of Great Britain, under the brand name "Lovibond".

The supplier will be asked to provide the services of a technical consultant to conduct a training program in the use of the Cholinesterase Monitoring Test Kits for MOPH management and technicians assigned to the locust control program. The consultant must (1) have specific, extensive experience in the use of the Lovibond Cholinesterase Monitoring Test Kits, (2) have extensive experience in training technicians from developing countries in the use of these kits under field conditions and (3) be able to inspect the consignment of the test kits and verify their condition and suitability for immediate use in the project. Therefore, it is appropriate that the manufacturer provide these services in addition to the kits. The value of the required person month of training/consulting services is estimated to be $12,500.

Pursuant to Handbook IB, Chapter 5B 4a (2) a waiver of the authorized geographic code for the procurement of commodities is permitted if "the commodity is not available from countries or areas included in the authorized geographic code." In this case, the commodity is only available from a manufacturing firm in Great Britain, which is in Geographic Code 935.

You have authority under AID Redelegation of Authority NO. 654 to waive U.S. (Code 000) source and origin to permit procurement of goods and services from Geographic Code 935 (Special Free World), when the cost of the goods and services does not exceed $5 million per transaction. In this case, a waiver of source and origin of the commodities only is required; no waiver of nationality is required since the services are incidental to the purchase of the equipment under HB1, Supp B, ch 5B 1d (3).

RECOMMENDATIONS

That, based upon the above justification and the authority redelegated to you and by your signature below, you:

1. Waive the source and origin from code 000 to code 935 to permit procurement of 20 Cholinesterase Monitoring Test Kits and related training services at an approximate cost of $37,500 from countries included in code 935; and

2. Certify that "the exclusion of procurement from Free World countries other than the cooperating country and countries included in Code 941 would seriously impede attainment of U.S. foreign policy objectives and objectives of the foreign assistance program".

APPROVED _____ DATE: 2/10/89 DISAPPROVED _____

Charles W. Johnson
Director, USAID/Morocco

Drafted by: BBarrington, RLA:bf:1/5/89
Clearances: Cont:RWarin _____
Prog:JWiebler _____
AGR:REhrich _____

ANNEX G

DECIS WAIVER

OFFICIAL FILE

VZCZCRA0009EHU410
PP RUEHRA
DE RUEHC #0174 3460014
ZNR UUUUU ZZH
P R 1100122Z DEC 88
FM SECSTATE WASHDC
TO RUEHRA/AMEMBASSY RABAT PRIORITY 8235
INFO RUEHAS/AMEMBASSY ALGIERS 2613
RUEHTU/AMEMBASSY TUNIS 2788
RUEHKH/AMEMBASSY KHARTOUM 0193
RUEHDK/AMEMBASSY DAKAR 3865
RUTANA/AMEMBASSY NOUAKCHOTT 6349
BT
UNCLAS STATE 400174

LOC: 413 979
11 DEC 88 22
CN: 41802
CHRG: AID
DIST: AID

608-01

ACTION: AGR

DUE DATE: 12/14

INFO: DIR DIR2 PROG
AGCONS OFD CHRON

AIDAC LOCUST RABAT FOR HELLYER/KITTS

E.O. 12356: N/A
TAGS:
SUBJECT: LOCUSTS - APPROVAL OF DECIS WAIVER

1. ON DECEMBER 8, 1988, THE ADMINISTRATOR SIGNED A DOCUMENT WAIVING REGULATION 16 PESTICIDE PROCEDURES FOR THE USE OF DECIS (A SYNTHETIC PYRETHROID) IN THE LOCUST CONTROL PROGRAM IN THE KINGDOM OF MOROCCO.

2. THE WAIVER MAKES REFERENCE TO THE PROGRAMMATIC ENVIRONMENTAL ASSESSMENT (PEA) WHICH DISCUSSED SYNTHETIC PYRETHROIDS GENERALLY, WHILE ADDRESSING THE USE OF TWO SPECIFIC SYNTHETIC PYRETHROIDS FOR LOCUST CONTROL, LAMBDA-CYHALOTHRIN AND TRALOMETHRIN. IN PROVIDING GUIDANCE ON SYNTHETIC PYRETHROIDS, THE PEA CAUTIONED THAT THESE CHEMICALS ARE HIGHLY TOXIC TO AQUATIC ORGANISMS. THE WAIVER CITES THE PEA CAUTION, AS WELL AS THE SPECIFIC GUIDANCE THAT A BUFFER ZONE OF 500 METERS BE OBSERVED WHEN APPLYING PESTICIDES BY AIR NEAR AQUATIC ZONES.

3. FULL TEXT OF WAIVER BEING POUCHED TO MISSION.
SHULTZ
BT
#0174

NNN

UNCLASSIFIED STATE 400174

USAID/RABAT
C & R
12 DEC. 1988
RECEIVED
22

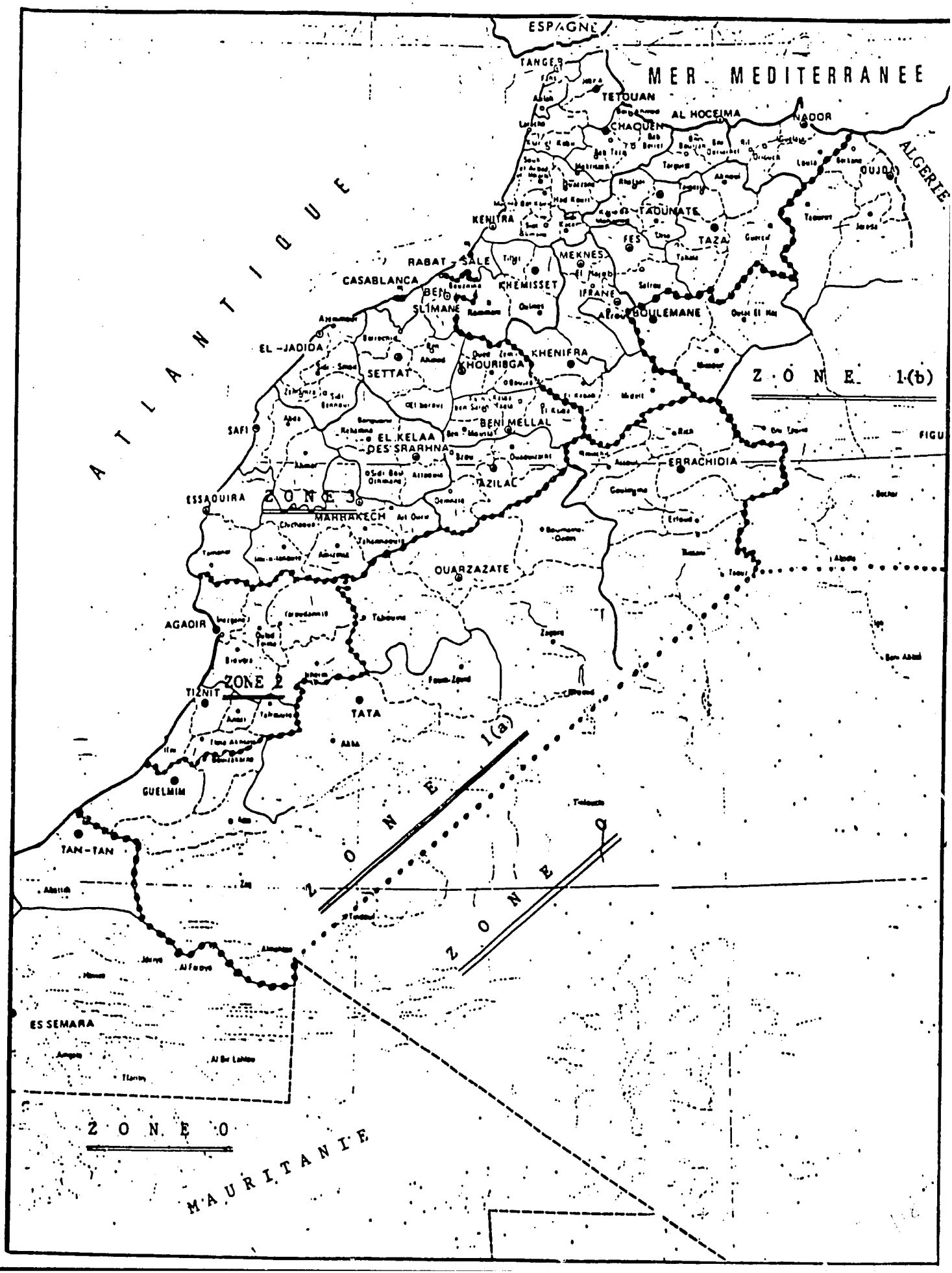
ACTION TAKEN
No Action Necessary
Replied by: _____
_____
_____
Initials & Date

ANNEX J

MAP OF AFFECTED AREA

ANNEX J

MAP OF AFFECTED AREA



ANNEX K

CLASS JUSTIFICATION FOR OTHER THAN FULL AND OPEN COMPETITION

ACTION AID3 INFO: ICM ECON/5

VZCZCRAO811EHV481
OO RUFHRA
DE RUEHC #3749 3492212
ZNR UUUUU ZZH
C 1422092 DEC 88
FM SECSTATE WASHDC
TO RUEHIL/AMEMBASSY ISLAMABAD IMMEDIATE 6190
INFO RUFHRA/AMEMBASSY RABAT IMMEDIATE 8313
RUEHTU/AMEMBASSY TUNIS 2840
RUFHSN/AMEMBASSY SANAA 9507
RUEHEG/AMEMBASSY CAIRO 0317
RUEHAM/AMEMBASSY AMMAN 2013
BT
UNCLAS STATE 403749

AIDAC FOR PAT PETERSON, ADO

TAGS: N/A
SUBJECT: LOCUST CONTROL -- EMERGENCY PROCUREM
OUTSIDE OF FULL AND OPEN COMPETITIVE PROCEDURE

OFFICIAL FILE
LOC: 418
15 DEC 88
CN: 42634
CHRG: AID
DIST: AID

608-0

ACTION: AGR
DUE DATE: 12/2
INFO: DIR DIR
AFCONS CHRO

1. YOU ARE AWARE OF THE SPREADING LOCUST PROBLEM AND THE POSSIBILITY OF AN INVASION OF PAKISTAN IN THE NEXT FEW MONTHS. LOCUSTS HAVE CAUSED SERIOUS PROBLEMS THROUGHOUT SUB-SAHARAN AFRICA AND PARTS OF NORTH AFRIC RECENTLY AND REQUIRED THE EXPENDITURE OF MILLIONS OF DOLLARS IN CONTROL ACTIVITIES. AS YOU KNOW THE LOCUST SITUATION IS A VOLATILE ONE THAT IS VERY DIFFICULT TO FULLY PREPARE FOR. EXPERIENCE HAS SHOWN US THAT TIMIN IS CRUCIAL IF EFFECTIVE LOCUST CONTROL IS TO BE DONE. PESTICIDES, TA, EQUIPMENT, ETC, MUST BE IN PLACE IN ADVANCE OF AN INVASION TO OFFER MAXIMUM PROTECTION AGAINST SERIOUS CROP DAMAGE. NEVERTHELESS, LOCUSTS AR SO UNPREDICTABLE THAT WE CAN'T POSSIBLY PLAN FOR ALL OF THE ALTERNATIVES THAT OCCUR DURING A SUDDEN INVASION. THERE MUST ALWAYS BE THAT ABILITY TO RESPOND QUICKLY TO UNFORESEEN INVASIONS AND THIS ESPECIALLY MEANS HAVING THE FLEXIBILITY TO PROCURE NEEDED SUPPLIES AND SERVICES ON AN EMERGENCY BASIS.

ACTION I
No Action Nece
Replied by: —
Init

2. ANE IS ACCUTELY AWARE OF THIS NEED AND HAS BEEN THE PROCESS OF DEVELOPING A MORE FLEXIBLE CONTRACTIN MECHANISM TO MEET THE REQUIREMENTS OF EMERGENCY PROCUREMENT. IN THIS REGARD M/SER/OP/OS HAS JUST FINALIZED A CLASS JUSTIFICATION FOR LESS THAN FULL A OPEN COMPETITIVE PROCUREMENT UNDER SITUATIONS OF QUO UNUSUAL AND COMPELLING URGENCY ENDQUOTE. THIS WAIVE APPLICABLE TO ALL ANE AND AFR BUREAU COUNTRIES ENGAG IN LOCUST CONTROL. IT WILL BE IN EFFECT FOR THE PER OF ONE YEAR AND ALLOWS BOTH AID/W AND MISSION CONTRACTING OFFICES TO DO FAST AND TIMELY PROCUREMEN OUTSIDE OF NORMAL COMPETITIVE GUIDELINES, WHEN IT IS

USAID/RAB
C & R
15 DEC. 1
RECEIVED

120

OFFICIAL FILE

CERTIFIED/THAT THE SITUATION IS OF UNUSUAL AND COMPELLING URGENCY.

3. WE ENVISION THIS MODIFIED PROCUREMENT PROCESS TO WORK AS FOLLOWS. A MISSION TECHNICAL OFFICER (WHOMEVER IS DESIGNATED AS THE LOCUST CONTROL PROJECT OFFICER) CERTIFIES IN A MEMORANDUM TO THE CONTRACTING OFFICER THAT A SITUATION OF "UNUSUAL AND COMPELLING URGENCY" EXISTS AND THAT THE CLASS JUSTIFICATION WAIVER OF FULL AND OPEN PROCUREMENT SHOULD BE INVOKED TO ALLOW FOR THE TIMELY PROCUREMENT OF X,Y,AND Z. THIS MEMO NEED ONLY BE A SHORT PARAGRAPH DESCRIBING THE SITUATION TO SUPPORT THE OFFICER'S CERTIFICATION. THIS MEMO CAN BE FAXED TO M/SER (OR PREPARED BY ANE/TR/ARD, PAUL NOVICK BASED ON MISSION'S CERTIFICATION OVER THE PHONE), IF THE PROCUREMENT MUST BE DONE IN AID/W. BASED ON THE CONTRACTING OFFICER'S ACCEPTANCE, THE MISSION SHOULD DEVELOP THE SPECIFICATIONS AND STATEMENT OF WORK ALONG WITH A PIO/C AND/OR PIO/T FOR THE PARTICULAR PROCUREMENT. NEXT STEPS ARE TO IDENTIFY POSSIBLE SUPPLIERS FOR THE CONTRACT OFFICER, MAKE A SELECTION, AND THEN DO A CONTRACT. IT SHOULD BE STRESSED THAT WHILE THIS QUICK PROCUREMENT AVOIDS ALL THE FORMAL REQUIREMENTS OF FULL AND OPEN COMPETITION, WE MUST STILL SOLICIT BIDS FROM AS MANY POTENTIAL SUPPLIERS AS POSSIBLE. THIS PROCESS MUST BE DOCUMENTED IN A MEMORANDUM TO THE FILE FOR EACH PROCUREMENT ACTION.

4. THE TWO CRITICAL AREAS WILL BE THE ACTUAL CONTACTING OF POTENTIAL SUPPLIERS AND THE CONTRACTING. WHO WILL DO THESE? IF THE MISSION OR GOP HAS THE TECHNICAL CONTACTS TO DO THE NECESSARY SURVEY OF SUPPLIERS, THEN YOU SHOULD MAKE YOUR CONTACTS DIRECTLY. IF NOT, THE DLTF/OFDA AND TR/ARD BACKSTOPPING OFFICERS WILL UNDERTAKE THIS RESPONSIBILITY ONCE WE RECEIVE YOUR SPECIFICATIONS. IF

YOU HAVE DIFFICULTY IN DEVELOPING THE TECHNICAL SPECIFICATIONS FOR THE PROCUREMENT ITEMS, THEN DLTF/OFDA CAN ALSO ASSIST YOU. IT SHOULD BE STRESSED HOWEVER, THAT THERE ARE ONLY A FEW TECHNICAL SPECIALISTS IN OFDA WHO ARE ALWAYS OVERWORKED. WE'LL FOLLOWUP ON YOUR REQUESTS BUT YOU SHOULD KNOW YOU WILL BE COMPETING FOR OFDA TECHNICAL SERVICES INVOLVED WITH SEVERAL OTHER DISASTER SITUATIONS ON-GOING IN THE WORLD. ON THE CONTRACTING SIDE, YOUR MISSION CONTRACTING OFFICERS SHOULD HANDLE THE PROCUREMENT WHENEVER POSSIBLE. M/SER/OP WILL UNDERTAKE THE ACTIONS WHEN THEY CAN'T BE DONE IN THE FIELD.

5. YOUR CONTACTS ARE AS FOLLOWS: ANE/TR/ARD, PAUL NOVICK (202) 647-7217; DLTF/OFDA KATE FARNSWORTH (202) 647-0685; M/SER/OP/OS, JUDITH JOHNSON (703) 875-1219.
SHULTZ
BT
#3749

121

VZCZCRA0889EHV759 CHRON COP'

PP RUFHRA

DE RUEHC #4098/01 3500304

ZNR UUUUU ZZH

P 150301Z DEC 88

FM SECSTATE WASHDC

TO RUEHMV/AMEMBASSY MONROVIA PRIORITY 5891

RUEHAH/AMEMBASSY KHARTOUM PRIORITY 0246

RUEHIL/AMEMBASSY ISLAMABAD PRIORITY 6202

RUEHKA/AMEMBASSY DHAKA PRIORITY 0088

RUEHEG/AMEMBASSY CAIRO PRIORITY 0331

RUEHNE/AMEMBASSY NEW DELHI PRIORITY 6996

RUEHKT/AMEMBASSY KATHMANDU PRIORITY 6620

RUEHSN/AMEMBASSY SANAA PRIORITY 9513

RUEHRA/AMEMBASSY RABAT PRIORITY 8320

RUEHTU/AMEMBASSY TUNIS PRIORITY 2846

RUEHME/AMEMBASSY MBABANE PRIORITY 5190

RUEHYI/AMEMBASSY YAOUNDE PRIORITY 7850

INFO RUEHAB/AMEMBASSY ABIDJAN PRIORITY 093

RUEHNR/AMEMBASSY NAIROBI PRIORITY 8995

BT

UNCLAS SECTION 01 OF 02 STATE 404098

LOC: 419 19
15 DEC 88 0740
CN: 42682
CHRG: AID
DIST: AID

608-019

ACTION: AGR

DUE DATE: 12/19

INFO: DIR, DDIR, PRO

AGCONS, OFM, CHRO

ATTAC FOR CONTRACTING OFFICER, REDSO/WCA, REDSO/ESA

E.O. 12356: N/A

TAGS:

SUBJECT: LOCUST CONTROL; CLASS PROCUREMENT JUSTIFICATION

HE FOLLOWING CLASS JUSTIFICATION IS AUTHORIZED FOR USE
Y CONTRACTING OFFICERS IN DEALING WITH LOCUST CONTROL
FFORTS:

ACTION TAKEN
No Action Necessary.
Replied by:
Initials &

LASS JUSTIFICATION FOR OTHER THAN FULL AND OPEN
OMPETITION; PROCUREMENT OF URGENTLY REQUIRED
ERVICES AND COMMODITIES FOR LOCUST CONTROL EFFORTS
N THE AFRICA AND ASIA/NEAR EAST REGIONS

GENERAL

HIS DOCUMENT IS A CLASS JUSTIFICATION FOR OTHER
HAN FULL AND OPEN COMPETITIO AS AUTHORIZED BY
ECTION 6.303-1(C) OF THE FEDERAL ACQUISITION
EGULATION (FAR).

HIS CLASS JUSTIFICATION MAY BE USED IN ACCORDANCE
ITH ITS TERMS BY ANY AID CONTRACTING OFFICER ACTING
ITHIN THE SCOPE OF HIS/HER DELEGATED AUTHORITY

USAID/RABAT C & R 15 DEC. 1988 RECEIVED 12

HIS CLASS JUSTIFICATION WILL APPLY ON A

ASE-BY-CASE BASIS WHEN CRITICAL AND URGENT
EQUIREMENTS DEVELOP FOR THE PROCUREMENT OF SERVICES
ND SUPPLIES, INCLUDING COMMODITIES, NECESSARY FOR
OCUST CONTROL EFFORTS IN THE AFRICA AND ASIA/NEAR
AST REGIONS. THE CONDITIONS FOR ITS USE ARE

IT HAS BEEN DETERMINED THAT THE AGENCY'S NEED FOR THE SERVICES AND SUPPLIES NECESSARY TO COMBAT LOCUST INFESTATIONS ARE OF SUCH UNUSUAL AND COMPELLING URGENCY THAT THE GOVERNMENT WOULD BE SERIOUSLY INJURED UNLESS THE AGENCY IS PERMITTED TO LIMIT THE NUMBER OF SOURCES FROM WHICH IT SOLICITS BIDS OR PROPOSALS. SECTION 6.302-2 OF THE FAR ENTITLED UNUSUAL AND COMPELLING URGENCY (10 U.S.C. 2304(C)(2)) IS THE CIRCUMSTANCE PERMITTING LESS THAN FULL AND OPEN COMPETITION WHEN THESE CONDITIONS EXIST, AND IS THE BASIS FOR THIS JUSTIFICATION.

THIS CLASS JUSTIFICATION MAY BE USED ONLY TO RESPOND TO THE URGENT REQUIREMENTS STATED IN THE ABOVE PARAGRAPH, AND WHEN THE BELOW CONDITIONS HAVE BEEN SATISFIED.

II. CONDITIONS FOR USE

A. OFFERS FOR THE REQUIRED SERVICES AND SUPPLIES WILL BE REQUESTED FROM AS MANY OFFERORS AS IS PRACTICABLE UNDER THE CIRCUMSTANCES.

B. APPLICATION OF THIS CLASS JUSTIFICATION WILL BE MADE ONLY ON A CASE-BY-CASE BASIS AFTER THE COGNIZANT TECHNICAL OFFICE IN THE ANE/AFR BUREAU/MISSION CERTIFIES IN WRITING TO THE COGNIZANT CONTRACTING OFFICER THAT UNUSUAL AND COMPELLING URGENCY AS DISCUSSED IN THE CLASS JUSTIFICATION APPLIES TO THE PROPOSED PROCUREMENT ACTION, AND REQUESTS THAT THE CLASS JUSTIFICATION BE INVOKED. OTHERWISE, NORMAL PROCUREMENT GUIDELINES WILL APPLY.

III. CERTIFICATIONS AND FILE DOCUMENTATION

A COPY OF THIS JUSTIFICATION MUST BE INCLUDED IN THE CONTRACT FILE IN EACH CASE THAT IT IS INVOKED. THE FILE MUST ALSO CONTAIN A WRITTEN STATEMENT, SIGNED BY THE CONTRACTING OFFICER, THAT THE CONDITIONS OF SECTION II ABOVE HAVE BEEN MET, THAT THE TECHNICAL OFFICE CERTIFICATION OF II-B ABOVE IS CORRECT, TO

THE BEST OF HIS/HER KNOWLEDGE, AND THAT THE COST OF THE CONTRACT IS FAIR AND REASONABLE

IV. EFFECTIVE DATE AND TERM

THIS CLASS JUSTIFICATION IS EFFECTIVE ON THE DATE OF SIGNATURE BELOW, AND SHALL REMAIN IN EFFECT FOR ONE

122

DECEMBER 6, 1988 (SIGNED BY) JOHN F. OWENS
AID PROCUREMENT EXECUTIVE SHULTZ

B 1
4098

N NNN

UNCLASSIFIED STATE 404098/02