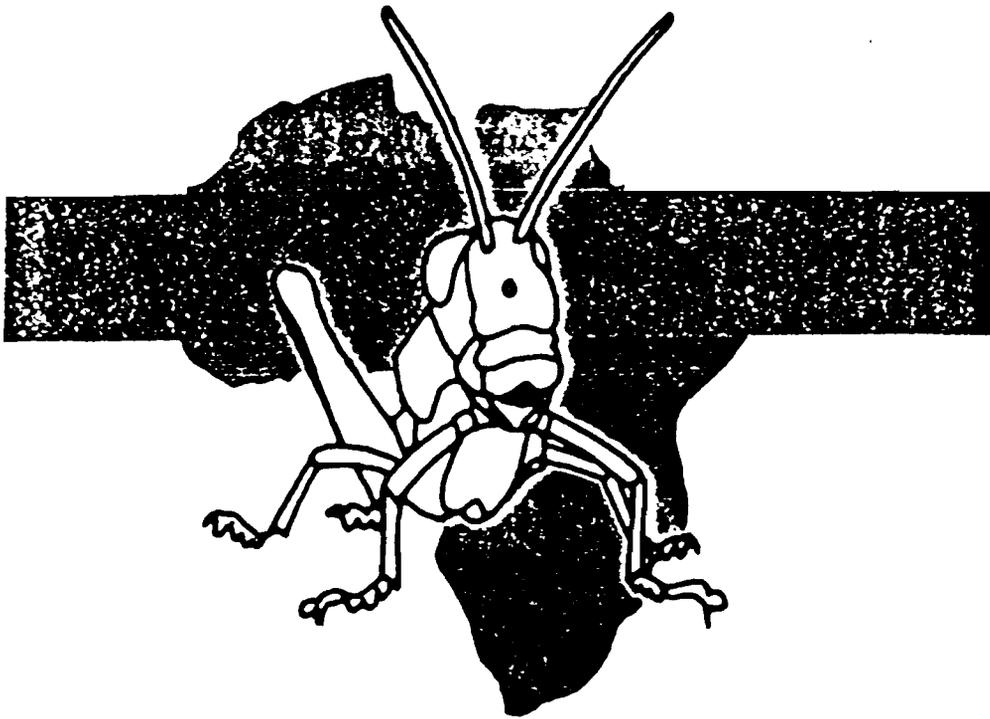


**Project Assistance Completion Report
(PACR)**



LOCUST CONTROL PROJECT
(608-0196)

**U.S. Agency for International Development
Rabat, Morocco
1993**

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**LOCUST CONTROL PROJECT
PROJECT ASSISTANCE COMPLETION REPORT**

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EXECUTIVE SUMMARY

Project Title:	MOROCCO LOCUST CONTROL PROJECT
Project Number:	609-0196
Project Amount (LOP):	\$23,500,000
First Obligation:	1988
Final Obligation:	1992
Country:	Morocco
Final Evaluation Report:	March 1992

1. PROJECT OVERVIEW

Morocco faced a serious threat of desert locust (DL) invasions due to climatic conditions that favored locust breeding and survival in the Sahel during 1987-88. The situation was extremely dangerous, as a large DL invasion would threaten at least 1.2 million hectares of highly productive agriculture in southern Morocco.

The Morocco Locust Control Project (MLCP) began in 1988 when desert locusts first directly threatened agricultural production in Morocco. At the time, the Government of Morocco (GOM) lacked the necessary institutional capabilities to combat a large DL invasion, and approached the international donor community for technical and financial assistance to deal with this threat. USAID initially responded to the emergency through the Office of Foreign Disaster Assistance (OFDA); on May 11, 1988 the MLCP was approved. Initial Life-Of-Project (LOP) funding was US\$3,500,000, with a Project Activity Completion Date (PACD) of 9/30/90. Procurement began immediately in preparation for the infestation cycle predicted for fall of that year.

In light of the ongoing threat, USAID/Rabat reassessed the MLCP in December, and decided to amend the project by increasing LOP funding by US\$20,000,000 and extending the PACD by nine months to 6/30/91.

The efforts deployed by the GOM, aided by USAID and other donors, enabled Morocco to avoid serious losses to DL during 1987 and 1988. Subsequently, and fortunately for Morocco, conditions did not favor continued DL breeding and the predicted invasions did not materialize beyond early 1989. However, given the hiatus caused by the Gulf War in 1990-91, the PACD was again extended to 06/30/92 in order to insure the adequate close-out of project activities. Total U.S. obligations for the MLCP from May 1988 to June 1993 were US \$7.1 million.

1.1 PROJECT GOAL AND PURPOSE:

The goal of the MLCP as defined in the Project Paper (Amendment no. 1) was: **"to protect Moroccan crops and livestock from the locust plague in ways consistent with protecting the health and well-being of people and the environment of Morocco".** The Project purpose was to: **"Assist the Government of Morocco, in coordination with other donors, to control desert locusts".**

2. COMPLETION STATUS OF PROJECT ELEMENTS AND SUMMARY OF INPUTS

The Government of Morocco calculates the total cost of the program at \$90 million, of which \$30 million were provided by donors. The ultimate authorized A.I.D. funding for the MLCP was \$23.5 million, of which only \$13.5 million were obligated. After the Project was amended, few locusts were reported and control operations were halted on March 5, 1989. However, from available financing, \$2,211,403 was spent from spring 1989 to spring 1992 for the demobilization of aircraft, the purchase of greenness maps, environmental monitoring studies and the procurement of certain commodities.

2.1 AIRCRAFT RENTAL

The MLCP provided the flying hours of two Turbo Thrushes and two DC-7 which were rented from T&G Aviation as a follow up to an AID/OFDA contract. These airplanes (i.e., Turbo Thrushes) were the first to come into action against DL in Morocco in November 10, 1987. According to the MLCP Final Evaluation, these aircraft and the U.S. pilots assigned to the program received high marks from GOM officials.

2.2 COMMODITY PROCUREMENT

2.2.1 INSECTICIDE: The only pesticide purchased by USAID for the MLCP was malathion. This pesticide is labeled by USEPA for grasshopper/locust control on rangeland and certain crops. Pesticides were promptly delivered to the GOM, followed by 10 forklifts to facilitate the movement of barrels. The procurement of forklifts and wooden pallets greatly minimized drum damage and facilitated handling.

2.2.2 SPRAY SYSTEMS: Ten pesticide Simplex 7000 spray systems, which allowed GOM Bell 205 helicopters to be used in spraying operations, were purchased through the MLCP. This greatly increased GOM treatment capacity for rapid mobilization into difficult terrain or where accuracy was essential.

2.2.3 MISCELLANEOUS/LOGISTICAL COMMODITIES: Other commodities purchased to enhance the operation's efficiency and management included 62 communication radios, "dry break" systems and greenness maps. According to Moroccan communication technicians, these radios were solid, practical and efficient. The "Dry break" connections resulted in large reduction in the number of pesticide spills during loading operations, while improving employee safety in the work place. Finally, the greenness (satellite image) maps aided the GOM in monitoring areas favorable for DL breeding and in identifying places requiring intensive ground surveillance. According to GOM officials, the supply of greenness maps was very valuable to the success of their operation.

2.2.4 ENVIRONMENTAL, HEALTH & SAFETY COMMODITIES: One of the major concerns associated with the spray campaigns in 1987/88 and 1988/89 was the exposure of workers to the insecticides used. USAID provided 2200 kits of protective clothing for workers who were in direct contact with pesticides to prevent skin exposure and inhalation. USAID also procured fifteen (15) Cholinesterase Testing Kits to be used by Moroccan medical personnel at the regional command posts to screen personnel for overexposure to pesticides every two weeks. Each kit provided enough material for conducting 1,000 tests. These kits proved to be an effective tool for enabling medical personnel to identify and, if necessary, treat exposed workers, and greatly promoted the concept of human health and safety while handling pesticides.

USAID also provided 5,500 pallets and 10,000 new steel drums. The latter addressed an urgent need for new containers, as many of the storage drums were badly corroded and leaking. In addition, USAID provided barrel crushing equipment to the GOM, which was used in the destruction of pesticide-contaminated barrels, thus preventing their reuse and minimizing the risk of accidental poisoning of humans or livestock.

2.3 TRAINING AND TECHNICAL ASSISTANCE

USAID provided training and technical assistance to GOM personnel in four areas: a) installation, use and maintenance of Simplex 7000 spray systems for GOM Bell 205 helicopters; b) entomology, pesticide safety, prospection & surveillance, and the interpretation of greenness maps; c) environmental monitoring through the Denver Wildlife Research Center (DWRC) Ecotoxicology Project, and d) cholinesterase monitoring and poison control.

USAID helped the GOM to organize a comprehensive training program in preventive health care in the spring and summer of 1988 for health care professionals (45 M.D.s and 130 nurses). These efforts significantly contributed to lowering the number of people accidentally poisoned by pesticides during DL control operations.

In early 1992 the DWRC, in collaboration with the GOM's Ministry of Agriculture and Agrarian Reform, undertook a study on the effects of pesticides used on Moroccan fauna. The Project provided training for 35 Moroccan scientists & technicians in ecotoxicological methods, and furnished technical assistance to examine the available options for the disposal of banned pesticides, and funded travel for GOM officials to a test-burn of dieldrin in Pakistan and to the 1990 Pesticide Disposal Conference in Niger.

3. REVIEW OF ACCOMPLISHMENTS (OUTPUTS)

The Project's goal of safely protecting Moroccan crops and livestock appears to have been well-achieved in that no significant damage to crops or livestock occurred and, as important, there were no reports of serious harm to human health.

3.1 ENHANCED GOM CAPACITY TO CONTROL DL THROUGH AERIAL SPRAYING

Before 1987, the Kingdom of Morocco had the capability to treat less than 2,000 hectares per day. Donor assistance has increased the efficiency of operations 10-15 fold (20,000-30,000 hectares per day), largely through MLCP efforts like the provision of aircraft, pilots and helicopter spray systems. This clearly demonstrates a profound improvement in operational capability.

3.2 IMPROVED STRATEGIC PLANNING/CONTROL TACTICS

One of the major accomplishments of the MLCP was to assist the GOM to improve strategic planning and tactics of control. With the assistance of international donor community, led by logistical support from USAID, the GOM has developed a highly effective control strategy to suppress DL swarms before they can cross the Anti-Atlas mountains.

3.3 IMPROVED EFFICIENCY OF OPERATIONS, (SURVEY, TREATMENT AND OPERATIONS)

The GOM's capacity for survey, treatment and communications increased dramatically as the campaign progressed and international assistance arrived. The consensus now is that the GOM is well-positioned to undertake a similar campaign in the near future. The above-mentioned increases in treatment capability can be attributed in large measure to the proper application of all the inputs, both GOM and donor-supplied, by a highly-effective GOM control organization.

3.4 IMPROVED CAPACITY TO MANAGE & MONITOR ENVIRONMENTAL, HEALTH AND SAFETY ASPECTS OF CONTROL OPERATIONS

The Project made several significant contributions to the GOM's capacity to manage and monitor human health and the environment by:

- a. Providing high quality protective clothing, cholinesterase test kits, and training in cholinesterase testing. These resulted on a reduction of number of treated persons for poisoning from over 400 persons in the initial campaign to only 23 cases during the second campaign.
- b. Financing of an environmental impact study of pesticide on the fauna of Morocco.

- c. Training Moroccan biologists in techniques of ecotoxicological assessment and analytical chemists in pesticide residue analyses.

4. REVIEW OF PROJECT EVALUATIONS & FINDINGS

4.1 THE FINAL EVALUATION

A team of five experts evaluated the MLCP in March 1993. The evaluators concluded that the Project's goal of protecting Moroccan crops and livestock in a safe manner appears to have been well-achieved in that no significant damage to crops and livestock occurred, and no reports of serious harm to human health or the environment were registered. With respect to each intended output, the team's findings were generally quite positive. A number of recommendations were offered, chiefly regarding follow-up actions and dissemination of Project results.

4.2 DENVER WILDLIFE RESEARCH CENTER STUDY

The U.S. Department of Agriculture-affiliated DRWC conducted a series of ecotoxicological studies on the effect of major pesticides used in Morocco's locust control operations (malathion and dichlorvos (DDVP)) in January and February of 1992. The studies were designed to evaluate the effect of these chemicals on birds, mammals and insect fauna on large experimental plots in southern Morocco. Some technical complications related to weather, experimental design and equipment malfunction were experienced by the DWRC research team which made these studies inadequate for strict statistical analysis. The study was successful, however, in providing training and hands-on experience to Moroccan scientists in ecotoxicological research, which was one of the primary objectives of the DWRC project. In technical terms these experiments determined that:

- Malathion quickly decomposed on contact with the soil, decreasing 85-90% after one-week;
- Residues of malathion and dichlorvos in vegetation inside treated plots were low;
- Mild physical effects were found only on one bird species (Talka swallow), but at levels not sufficient to suggest serious impairment. No effects were observed in other vertebrates examined;
- No bird or mammal mortality occurred in treated plots, and no significant effects were found affecting their numbers or normal activity in the pesticide-treated plots;
- Malathion caused extensive mortality of ants, bees, beetles and grasshoppers/locusts, while dichlorvos only affected the abundance of beetles in treated plots.

5. SUMMARY OF SELECTED LESSONS LEARNED

1. The highly-disciplined structure of the national locust control organization that managed the operations proved successful and efficient;
2. The continued functioning of a national locust control organization is useful in maintaining a degree of preparedness;
3. USAID inputs contributed greatly to the safety and efficiency of operations;
4. The use of large aircraft in relatively unpopulated and non-agricultural areas appears to be feasible;
5. Future locust control projects sponsored by USAID should provide funding for professional pesticide inspection services;
6. A regional approach for the prevention of DL outbreaks is essential;
7. Pesticides should be ordered only "as needed" to the extent practicable in order to avoid the accumulation of stocks;
8. A pesticide management plan should be developed by USAID for each future project in which pesticides are provided;
9. The provision of Cholinesterase testing kits should be a standard input into projects using large quantities of pesticides.
10. Areas where pesticide spillage is likely to occur should be well prepared to contain spills; and
11. To the extent practical, wildlife censuses should be performed prior to large control campaigns.

LIST OF ACRONYMS

AchE	Acetylcholinesterase
A.I.D.	Agency for International Development
DL	Desert Locust
DWRC	Denver Wildlife Research Center
FAO	United Nations Food and Agriculture Organization
GOM	Government of Morocco
ha	Hectare(s)
LOP	Life-of-Project
MARA	Ministry of Agriculture and Agrarian Reform
MLCP	Morocco Locust Control Project
NIOSH	National Institute for Occupational Safety & Health
OFDA	Office of Foreign Disaster Assistance
PACD	Project Activities Completion Date
PC	Command Post
PCC	Central Command Post
PCR	Regional Command post
PM	person month
ULV	Ultra-Low-Volume
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
WHO	World Health Organization

1. PROJECT OVERVIEW

The Morocco Locust Control Project (MLCP) had its origins in October of 1987 when desert locusts (DL) threatened agricultural production of the Kingdom. At the time, the Government of Morocco lacked the necessary institutional and material capabilities required to control a desert locust invasion of plague proportions. Recognizing the threat, the Government of Morocco (GOM) approached the international donor community to obtain emergency technical and financial assistance. The U.S. Agency for International Development (A.I.D.) Office of Foreign Disaster Assistance (OFDA) promptly responded to GOM's call for relief by providing US\$446,686 in emergency financial contributions for technical assistance, pesticides, and commodity procurement.

To insure continued U.S. support to the GOM after expiration of OFDA's statutory limit on emergency assistance (i.e. 90 days), USAID/Rabat immediately began to design the MLCP during the late fall of 1987. This effort would establish a long term mechanism to assist the GOM which faced the likelihood of larger DL invasions for 1988. The predictions became a reality when, early in the spring of 1988, large DL swarms invaded the country. OFDA provided needed assistance during the interim period while the MLCP was being designed, contributing US\$1,835,840 in additional assistance.

In May 11, 1988 the Morocco Locust Control Project (MLCP) was approved. Initial Life-Of-Project (LOP) funding was US\$3,500,000, with a Project Activity Completion Date (PACD) of September 30, 1990. Procurement began immediately, allowing enough time to prepare for the fall cycle infestation predicted for later that year. By the fall of 1988, A.I.D. support for controlling the DL plague in Morocco came from two sources: OFDA emergency funds and the MLCP.

Climatic conditions favored continued locust breeding and survival in the Sahel in 1988. By early September 1988, a DL population explosion reached from Sudan to southeastern Mauritania; control efforts undertaken by Sahelian countries had virtually no impact on the plague. The situation in Morocco was extremely dangerous from late October to January, threatening of at least 1.2 million highly-productive hectares.

In light of this threat, USAID/Rabat reviewed the MLCP in December and decided to amend the project by increasing LOP funding to US\$23,500,000, and extending the PACD by nine months up to June 30, 1991. This amendment was based on well supported expectations that serious threats from DL would continue through 1989, if continued rainfall occurred in southern Morocco and northwest Mauritania. Fortunately for the region, the prevalent conditions did not favor DL breeding, and the predicted of invasions did not materialize beyond early 1989. The Gulf War interval in 1990-91 prompted the Mission to extend the PACD June 30, 1992, in order to insure an orderly close-out of project activities. Total U.S. expenditures in Morocco for the DL control operations (November 1987-June 1992) were US\$9.7 million (US\$2.6 million from OFDA and US\$7.1 million from the MLCP).

1.1 PROJECT GOAL

The goal of the USAID Morocco Locust Control Project as defined in the Project Paper (Amendment 1) was: **"to protect Moroccan crops and livestock from the locust plague in ways consistent with protecting the health and well-being of people and the environment of Morocco"**. The project goal was achieved as the GOM was enabled to mount successful control operations to prevent crop damage or economic loss in major agricultural areas, like the Souss and Massa valleys, during the plague.

The Final Evaluation team was most impressed by the quality and effectiveness of the MLCP. According to this report the project's goal was "well-achieved in that no significant damage to crops and livestock occurred, and no reports of serious harm to human health or the environment were registered". Moreover, with respect to each intended output, the team's findings were very positive; specifically, the significant increase in safely treated area and the well organized utilization of all the inputs of the GOM and donors.

1.2 ACHIEVEMENT OF PROJECT PURPOSE

The objective of the MLCP was to: **"Assist the Government of Morocco, in coordination with other donors, to control desert locusts"**. The project purpose was properly met. Funds for assistance to the MLCP have allowed the GOM to provide continuous DL surveillance and control capabilities, well after PACD, by putting in place:

- Expanded GOM capacity to control DL through a well maintained network of surveillance and control posts;
- Improved GOM ability to manage the timely prepositioning of pesticides and aircraft to control DL, and by the development of strategic plans and modern pest control tactics appropriate for the country;
- A well trained cadre of experienced pilots, survey teams, radio operators, and crop protection technicians versed in state-of-the-art pest control tactics, and capable to meet future treats by pests like the DL, or health threats like mosquito/vector control;
- Improved skills of Moroccan medical professionals to prevent, diagnose and treat pesticide poisonings among DL control work crews, and the general public; and
- An enhanced capacity to conduct DL campaigns in a sound environmental manner.

Coordination of international donor assistance was critical to the enhancement of Morocco's capacity to fight DL. More than a dozen donor organizations gave contributions during the locust plague of 1986-88. This coordinated assistance for the

procurement of supplies has allowed the GOM to maintain aerial treatment capability, which at the time of the Final Project Evaluation was estimated to be about 20,000 to 30,000 ha. per day ¹. Training of GOM participants on safe and effective use of pesticides by various donors helped considerably to lower the number of accidents during the crisis. For instance, USAID sponsored training of health practitioners on the use of Cholinesterase testing to avoid pesticide poisonings, the FAO sponsored a course on pesticide application techniques (ground and aerial) at the National Desert Locust Control Center (NLCC) at Ait Melloul for GOM technicians, and the Pesticide Analysis Laboratory received support in instrumentation and training from GTZ (Germany) and USAID.

2. COMPLETION STATUS OF PROJECT ELEMENTS AND SUMMARY OF INPUTS

The Government of Morocco calculates that the total cost of the DL control program was \$90 million dollars with \$30 million provided by donor assistance. The MLCP was initially funded by an obligation of \$3.5 million and a PACD of September 30, 1990. The project was amended in February of 1989 to increase authorized funding level to \$23.5 million (of which an additional \$10 million was ultimately obligated) and a PACD of June 30, 1991 (later extended to June 30 1992 due to the Gulf War). This brought the cumulative obligation of the MLCP to \$13.5 million at PACD. Following approval of the Project Amendment few locusts were reported in Morocco, and control operations were halted on March 5, 1989. However, from available financing, \$2,211,403 was spent from spring 1989 to spring 1992 for the demobilization of aircraft, the purchase of greenness maps, environmental monitoring studies and the procurement of certain commodities.

¹ For example, in 1987 the GOM started with a small number of aircraft--approximately 20-- while the final total was 56 aircraft (42 airplanes and 14 helicopters).

Table 1. Summary of Morocco Locust Control Project (608-0196) Funding Activities by Element*

Project Element	U.S. Dollar Value	
	Obligations	Expenditures
Aircraft flying hours	948,695	904,694
Pesticides	2,258,265	1,977,610
Spraying Systems	312,000	725,023
Misc. Commodities	177,000	162,111
Env. Health & Safety Commodities	392,000	1,229,830
Logistical Commodities	539,000	537,358
Training and Tech. Assistance	927,000	837,434
Contingencies	1,549,000	76,005
Subtotal	7,102,960	6,450,065
Deobligated	6,397,040	
Total	13,500,000	
Total Obligated	7,102,960	
less Expenditures	6,450,065**	
Total remaining (unexpended)	652,895**	

* As of June 16, 1993

** Of this amount, \$379,971 has been committed to DWRC. The balance of \$272,924 will be deobligated per Section 1311 Review.

2.1 AIRCRAFT RENTAL

The MLCP provided the flying hours of two Turbo Thrushes and two DC-7, which were rented from T&G Aviation, Chandler, Arizona. These airplanes (i.e., Turbo Thrushes) were the first aircraft provided by the donor community to come into action against DL in Morocco, carrying out their first spraying mission on November 10, 1987. The two Thrushes treated a total of 168,805 ha, and its pilots logged a total of 282 flying hours. The DC-7 treated almost twice as many hectares (314,180 ha) in just 160 flying hours. **Based on their favorable experience, specially with the versatile Turbo Thrushes, GOM officials decided to buy 10 of these U.S. manufactured aircraft to supplement their own DL-fighting forces.**

According to the MLCP Final Evaluation, both the aircraft and the U.S. pilots received high marks from GOM officials. The maneuverable Thrushes were used in the rugged mountainous terrain and narrow valleys of the Atlas mountains, while the larger DC-7s and the C-130 were used over open, non-agricultural terrain and rolling flat lands. The DC-7s played a key role in the MLCP by being able to cover missions

of a much longer range, with their ability to spray up to 10 times the number of hectares as the Turbo Thrush per mission with less personnel. The addition of these large aircraft made it possible to reach distant and rapidly moving DL swarms in the vast unpopulated areas of the Moroccan desert.

Table 2. Summary of Major Inputs and Status: Aircraft

Aircraft	Period	Description
Turbo Thrush	May 15, 1988- June 30, 1988	Rental for two aircraft;
DC-7	January-June 30, 1989	Rental for two DC-7 aircraft;

2.2 COMMODITY PROCUREMENT

2.2.1 INSECTICIDE

The only pesticide purchased by USAID for the MLCP was the organophosphate pesticide, malathion. This relatively low mammalian toxicity pesticide is labeled by USEPA for grasshopper/locust control on rangeland and certain crops. The pesticide was supplied by Cyanamid International Sales Co. (Cyanamid Plaza, Wayne, N.J.) in Ultra-Low-Volume (ULV) formulation. This ULV formulation increased the treatment efficiency by increasing the area which could be covered on a single load, and virtually eliminated the need to transport dilution materials or mix them in the field.

The malathion was promptly shipped and delivered to the GOM, followed by the procurement of 10 forklifts to facilitate the movement of barrels, and improve warehouse/inventory management. At the beginning of the campaign, barrels were rolled off trucks onto tires to cushion the fall. Most, if not all, of the barrels received their major damage in this operation, leading to some pesticide leakage. Procurement of forklifts and wooden pallets greatly minimized drum damage and facilitated pesticide handling.

Table 3. Summary of Major Inputs and Status: Pesticides

Commodity	Period	Status	Description
Pesticide	Jan 88- June 89	completed	400,000 Liters of Malathion ULV
Fork Lifts	Jan- June 91	completed	10 Fork Lifts for Pesticide Management

2.2.2 Spray Systems

Ten Simplex 7000 pesticide spray systems, which allowed GOM Bell 205 helicopters to be used in spraying operations, were purchased by the MLCP. Outfitting GOM helicopters with proper spray equipment and training their pilots on their efficient use greatly increased GOM capacity to work in difficult terrain where accuracy was essential. Recent reports indicate that the GOM has maintained the use of these helicopter crews and their USAID-procured spraying systems for pest control

operations, such as the control of mosquitoes in recent anti-malarial campaigns.

Table 4. Summary of Major Inputs and Status: Spray Systems

Commodity	Period	Status	Description
Spray Systems	October 1988- January 1989	completed	Spray equipment for 10 GOM Bell 205 Helicopters; technical expert.

2.2.3 Miscellaneous and Logistical Commodities

Efficient radio communication was essential for the success of the MLCP considering the size and distances of most operations. To assure efficient communications between the operations site, aircraft, the spray block, and the command center, USAID supplied the GOM with 62 communication transceiver radios. According to Moroccan communication technicians, USAID-procured radios were solid, practical and efficient. Currently, the Central Command Post in Rabat maintains a central information system which is equipped with this radio equipment and is used daily to communicate with key Command Posts throughout Morocco.

Another important contribution by the MLCP to the GOM were the Dry break systems. Initially, the transfer of pesticides from drums to aircrafts was accomplished by heavy suction pipes, which had to be lifted from barrel to barrel by hand. Workers tended to use both arms to lift the pesticide covered pipe, resulting in major contamination of their protective clothing, a hazard to their health, and a major source of pesticide spills and leakage. The Dry break connections provided by USAID were a vast improvement over the original situation and resulted in large reduction in the number of pesticide spills during loading operations, while improving employee safety in the work place.

Finally, USAID procured greenness maps (satellite image) to assist GOM in monitoring areas favorable for DL breeding, and to identify places requiring intensive ground surveillance. These Greenness maps were produced from satellite images by the EROS Data Center, U.S. Geological Survey, in Sioux Falls, South Dakota. USAID supplied these maps to GOM on a 10-day cycle during the campaign, and continued to supply them under the MLCP until April 1992. The MLCP also sponsored participant training in the use and interpretation of greenness maps, thus exploiting the maps' full potential in the fight against DL. According to interviews of GOM officials by the Final Evaluation team, the supply of greenness maps was considered extremely valuable to the success of their DL control operations.

Table 5. Summary of Major Inputs and Status: Miscellaneous and Logistical Commodities

Commodity	Period	Status	Description
Two-way Radlos	May 15-June 30, 1988	completed	62 HF & VHF transceivers and communications/ navigational equipment
Dry Break Systems	January-June 1989	completed	20 Dry break systems
Equipment Installation	January-June 1990	completed	Installation of 2 Gas Chromatographs
Wooden Pallets	January-June, 1991	completed	5,500 pallets for re-drumming and storage of pesticide stocks
Greenness Maps	January-June 1989	completed	Greenness maps of Mali, Niger, Mauritania and Morocco;

2.2.4 Environment Health & Safety Equipment

One of the major concerns for human health associated with the DL control campaigns in 1987/88 and 1988/89 was the exposure of workers to poisoning due to the toxic nature of the organophosphate insecticides used. USAID made an important contribution to worker safety by providing 2200 kits of protective clothing, each consisting of coveralls, gloves, boots, respirators and goggles. These were used by workers who were in direct contact with pesticides to prevent skin exposure and inhalation. The respirator masks were NIOSH-approved, 3M Easy-Air 7200 dual-cartridge respirators, for which an ample supply (over 30,000 units) of 3M 7521 Organic Vapor cartridges was procured.

In addition, USAID encouraged GOM officials to conduct regular measurement of serum acetylcholinesterase (Ache) for people involved in the campaign: pilots, navigators, mechanics, technicians, drivers, military personnel and all workers charged with pesticide application, formulation and handling. USAID procured fifteen (15) Lovibond Cholinesterase Testing Kits (AF267) to be used by Moroccan medical personnel at the regional command posts in bi-weekly screenings of all personnel for overexposure to pesticides. Each of these Lovibond Kits provided enough material for conducting 1,000 tests. The Kits proved to be an extremely effective tool to GOM medical personnel, allowing them to accurately identify, treat and, remove exposed workers, and thus greatly promoting health and safety standards in handling pesticides operations.

To further improve work place safety and mitigate the environmental impacts caused by leaking pesticide barrels, USAID provided 5,500 pallets and 10,000 new steel drums. With this procurement USAID addressed an urgent need for new containers

(as many of the stored drums were badly corroded and leaking). USAID also provided large plastic stick-on labels for products that were re-drummed, which provided space for writing information on the type of pesticide, the date of re-drumming, and other required information. In addition, USAID provided barrel crushing equipment to the GOM for use in the destruction of pesticide-contaminated barrels. Destruction of these drums was included as a covenant to the Grant Agreement, in order to prevent their reuse and minimizing the risk of accidental poisoning of humans or livestock.

Table 6. Summary of Major Inputs and Status: Environment Health & Safety Equipment

Commodity	Period	Status	Description
Cholinesterase Test Kits	May 15, 1988-June 30, 1989	completed	Cholinesterase testing kits (35);
Protective Equipment & Environmental Supplies	May 15-June 30, 1988 June-September, 1990	completed	Protective clothing: Masks, overalls, boots, gloves, goggles (2,200 sets)
Vehicles	May-June, 1990	completed	one 4-wheel-drive vehicle.
Drum Disposal System	January-June 1989	completed	2 Drum Disposal Systems
Environmental Testing and Monitoring Equipment	Jan 1990-June 1992	completed	Environmental Monitoring and Computer Equipment
New Metal Drums & Wood Pallets	Jan 1990-June 1992	completed	10000 steel drums & 5,500 wooden pallets for proper pesticide storage

2.3 TRAINING AND TECHNICAL ASSISTANCE

The USAID-sponsored training produced a large cadre of personnel experienced in all phases of locust control. USAID provided training in four major areas: a) installation, use and maintenance of Simplex 7000 spray systems for GOM Bell 205; b) pesticide application techniques; c) environmental monitoring by the Denver Wildlife Research Center ecotoxicology project; and d) cholinesterase monitoring and poison control.

Although the Kingdom of Morocco has one of the most efficient, best trained and equipped Crop Protection Services, it was small and lacked the experience necessary to confront the size of the desert locust problem faced. During the 1987 campaign, 423 workers became ill from pesticide poisoning which required their treatment or hospitalization. Therefore, the MLCP immediately helped the GOM to organize a comprehensive preventive health care program in spring and summer of 1988. The

program involved the provision of U.S. training and technical assistance to the existing health care system at the provincial and local levels (45 M.D.s and 130 trained nurses). Courses were set up, using the well respected WHO publication *"Poisoning by Insecticides: Prevention, Diagnostics and Treatment"* (WHO/UBC 84.889, R. Plestina) as a manual. Dr. Plestina, a world class expert in the prevention of pesticide poisonings, offered this course. USAID provided test kits for monitoring cholinesterase levels became a significant part of the health protection system during the second campaign. These combined efforts significantly contributed to lower the number of people accidentally poisoned by pesticides during DL control operations in Morocco after 1987.

In 1989, USAID requested the Denver Wildlife Research Center (DWRC) to conduct a cooperative project with the GOM's Ministry of Agriculture and Agrarian Reform (MARA) to study the effects of malathion and DDVP on Moroccan fauna, in two phases. The first phase, in 1990, placed emphasis on training by organizing five (5) training sessions for more than 50 Moroccan scientists. These sessions were: 1) "The history, concepts, and conduct of ecotoxicology studies"; 2) "Methods for organophosphate insecticide residues in field samples"; 3) "The use of wildlife telemetry in ecotoxicological studies"; 4) "Population Ecology of birds, mammals, and invertebrates"; 5) "Experimental design and statistical analyses". These USAID-sponsored training sessions, which targeted Moroccan biologists and environmentalists, have prepared the GOM to set up and conduct ecotoxicological surveys in future DL control operations. The MLCP also sponsored technical assistance on the options available to the GOM for the disposal of banned and out-dated pesticides, and funded travel for GOM officials to a test burn of dieldrin in Pakistan and to the 1990 Pesticide Disposal Conference in Niger.

Finally, the GOM has not failed to stress the importance of the education and training that USAID has provided. This indeed seems to be the most important and constructive legacy that USAID assistance program left behind: groups of well trained experts ready to deal with DL control problems in the future.

Table 7. Summary of Major Inputs and Status: Training and Technical Assistance

Element	Period	Status	Description
Technical Assistance	May 15-June 30, 1988	completed	Insecticide Testing and Screening (1 PM)
Technical Assistance	May 15-June 30, 1988	completed	Locust Expert/Ecologist (1 PM)
Technical Assistance	May 15-June 30, 1988	completed	Pesticide Management/Safety Expert (1 PM)
Technical Assistance	June 1988-June 1992	completed	Project Coordinator
Technical Assistance	Jan. 1989- June 30, 1989	completed	Evaluation of Aircraft Applications (1 PM)
Technical Assistance	Jan. 1989- June 30, 1989	completed	DWRC Environmental Assessment and Monitoring (12 PM)
Training	May-December 1989	completed	Ecotoxicology Concepts; Insecticide Residue Analysis; Telemetry; Population Ecology; Experimental Design.

3. REVIEW OF ACCOMPLISHMENTS (OUTPUTS)

The MLCP Final Evaluation analyzed in detail locust control operations in Morocco. The Evaluation team was most impressed with the quality and effectiveness of the MLCP and concluded that the goal of safely protecting Moroccan crops and livestock had been well-achieved. The Team determined that no significant damage to crops and livestock occurred and, as important, no reports of serious harm to human health were recorded.

The MLCP logframe contained four output statements; the accomplishments of each are briefly reviewed below.

3.1 ENHANCED GOM CAPACITY TO CONTROL DESERT LOCUST THROUGH AERIAL SPRAYING.

During the DL control campaigns of 1987 and 1988, the GOM treated close to 4.8 million hectares using aerial and ground treatment. Prior to the start of USAID assistance (i.e., before 1987), the Kingdom of Morocco treatment capability was limited to less than 2,000 ha per day. There was also an acute shortage of trained technicians to undertake DL control operations, including handling of pesticides, swarm and hopper band prospection, and an inability to implement logistically

complex spraying operations. As experience was gained by ground and air crews, and as donor assistance increased, the efficiency of operations dramatically increased to the point that the capacity to counter DL invasions in Morocco has expanded 10-15 fold (20,000-30,000 hectares per day). A total of 4,800,000 hectares were treated during the 16 months of operations. According to the Final Evaluation, the GOM presently sustains the capacity to treat 20,000-30,000 ha per day on its own resources, which clearly suggests the significant improvement in operational capability.

USAID contributions have allowed the GOM to upgrade pesticide storage facilities, equipment and materials at the NLCC and around the Kingdom. It is important to note the critical function played by the National Locust Control Center (NLCC) at Ait Melloul during the 1997-1988 campaign. Principal activities of the Center included: surveillance; control, maintenance and distribution of inventories; training of technicians; and the coordination of DL treatment programs. USAID, in coordination with other international donor agencies, contributed greatly to enhance the NLCC's capability to counter future threat by DL plagues. In fulfilling its present role, the Center maintains several prospection/treatment teams composed of well trained personnel, ground spraying equipment, and large stock of suitable pesticides. In summary, the MLCP has assisted the GOM to acquire a well trained cadre of experienced pilots, survey teams, radio operators, and crop protection technicians versed in state-of-the-art pest control tactics and capable to meeting future threats by pests like the DL, or health threats like mosquito/vector control.

3.2 IMPROVED STRATEGIC PLANNING/ CONTROL TACTICS.

One of the major goals and accomplishments of the MLCP was to assist the GOM in the improvement of strategic planning and tactics for locust control, including preparation for appropriate responses north of the anti-Atlas mountains. Morocco has historically been highly vulnerable to DL invasions due to its geographical layout. The rich agricultural valleys between the Atlas and anti-Atlas mountains are specially threatened by the DL. These valleys usually trap DL swarms for extended periods of time during their migration, thus increasing the chances for devastating highly prized crops and fostering massive reproduction in their fertile soils.

With the assistance of international donor community, led by logistical support from USAID, the GOM developed a highly effective control strategy to suppress DL swarms before they could cross the Anti-Atlas mountains. This strategy consisted in simultaneously approaching a DL invasion by: a) the protection of the southwest and preventing DL from crossing the Anti-Atlas mountains, thus safeguarding southern valleys; and b) protecting the East by preventing swarms from crossing the High and Middle Atlas and entering the Morocco's north western agricultural zones. Using this strategy, the GOM was successful in providing the desired level of protection to the Souss and Massa Valleys (and central Morocco) from extensive damage by the DL.

Much of Morocco's improved capability to plan and execute a control strategy may be attributed to the National organization that was developed during the 1987-88 period --a structure which may be described as functional, comprehensive and well-

adapted to Moroccan conditions. It was also characterized by a high degree of cooperation among the concerned governmental services and agencies. An operational structure specific to the Morocco locust control program was developed which had four main levels of authority, consisting of:

Central Command Post (PCC): Situated in Rabat, the PCC assumed overall responsibility for implementing all locust control activities in the country, as well as coordinating all actions undertaken by the Regional Command Posts. The Commanding General of the Royal Gendarmerie was appointed by His Majesty the King to serve as National Coordinator and head the PCC.

Regional Command Posts (PCRs): Situated in the main cities of affected provinces and under the PCC's general direction, PCRs were responsible for the establishment of survey and treatment (ground and aerial) programs specific to needs of their region. Each PCR was headed by a Regional Coordinator, namely the Governor of the province, who was responsible for all administrative and financial matters. The Regional Coordinator was further supported by a designated agent from MARA who was responsible for all of the PCR's operational decisions, and an officer from the Gendarmerie Royale who facilitated execution. Representatives of different ministries were also assigned to each PCR, and acted under the authority of the MARA agent. Although equipped and organized to operate autonomously, PCRs depended upon the PCC for the approval of all decisions relative to control strategies, as well as for reinforcements whenever an infestation exceeded a particular PCR's capabilities.

Five (5) PCRs were initially established during the 1st campaign in the fall of 1987, and the number was increased to 12 in 1988 in response to more general locust invasion. PCRs were situated at Oujda, Bouarfa, Errachidia, Ouarzazate, Tata, Guelmim, Laayoune, Dakhla, Ait Melloul, Missouri, Khenifra and Marrakesh.

Sub-Command Post (SPC): Every PCR had 2-3 SPCs which were responsible for surveying, ground treatment and, on occasion aerial treatments. There were a total of 29 SPCs which reported to their corresponding PCR.

Operational Units (UO): There were 121 operational units in total under the control of SPCs. Every UO was responsible, within a defined territorial area, to undertake survey and limited ground treatment.

The Final Evaluation found that this organizational structure was comprehensive, both in terms of agencies involved and in terms of geographic coverage. The design of this organizational structure assured involvement and oversight by MARA and the Ministry of Interior, and ensured a well-organized array of technical capabilities unique among locust control programs in the African region. According to interviews and visits by the Final Evaluation Team there was also a clear sense of collaboration and cohesion, effective coordination between participating agencies, and good vertical communication between the PCC and PCRs.

3.3 IMPROVED EFFICIENCY OF OPERATIONS (SURVEY, TREATMENT AND COMMUNICATIONS).

The GOM's capacity for survey, treatment and efficient communications increased dramatically as the campaigns progressed and international assistance arrived. It was the consensus of the 1992 Final Evaluation that the GOM is currently well-positioned to undertake a similar campaign, at least for the foreseeable future. The great increases in treated capacity by the GOM (i.e., from less than 2000 ha. in 1987 to 30,000 ha today) can be attributed in large measure to the proper application by the well coordinated organization of all the inputs from both the GOM and donors. The volume of work successfully accomplished without any serious reported incidents speaks well of the overall management on all sides.

The size and efficiency of the DL control operations in Morocco improved dramatically. For example, most of these DL control activities were carried out by close to 200 ground-based survey teams assigned full time to the locust program. These teams had responsibility for prospection and the identification and marking of swarms for aerial treatment. Survey teams were assigned to PCRs and provided with vehicles, radios, and marking equipment. As swarms were sighted and reported, the teams were dispatched to the area to determine size, density, biological activity and location coordinates. Airplanes relied on USAID-supplied navigational aids or directional compasses for 180 degree back-and-forth runs coupled with markers on the ground. Ground survey teams in targeted areas worked with the pilots in burning tires for markers, using USAID-supplied flare bombs, or laying out bright fluorescent cloth with a large white arrow pointing toward the spray blocks.

It should be noted that when the locust control organizational structure in Morocco was compared to those of other countries in the region, the Final Evaluation team was most impressed. For all intents and purposes, the MLCP was comprehensive, well-coordinated and quite disciplined.

3.4 IMPROVED CAPACITY TO MANAGE & MONITOR HEALTH, SAFETY AND ENVIRONMENTAL ASPECTS OF CONTROL OPERATIONS

In the area of human safety, USAID made several significant contributions to the GOM capacity to manage and monitor human health and the environment by:

- Providing high quality protective clothing, cholinesterase test kits, and training in cholinesterase testing. These contributions, combined with the excellent health care and safety education system established in Morocco, resulted in the reduction of number of treated persons for symptoms of organophosphate poisoning from over 400 persons during the first campaign to 23 cases during the second campaign.
- Financing an environmental impact study concerning the effects of DDVP and malathion (the two most widely-used pesticides) on the fauna of Morocco, and which was conducted by the Denver Wildlife Research Center.

- Improving the storage conditions of pesticides. USAID's contribution in this area, as well as pesticide management in general, greatly reduced the potential for work place accidents and environmental contamination.
- Training Moroccan biologists in the techniques of ecotoxicological assessment and analytical chemists in pesticide residue analyses. These actions have generated necessary expertise which will be crucial for future pest control programs. Likewise, the installation of two gas chromatographs with phosphorus specific detectors enables the official laboratory in Casablanca to provide the needed capacity for pesticide residue analyses in Morocco.

The MLCP also contributed to greatly heighten worker safety and environmental awareness at all levels of Moroccan government. In the area of human safety, USAID made a significant contribution (through the provision of protective clothing, cholinesterase test kits, and training in cholinesterase testing). The availability of protective gear and the cholinesterase kits were definitely critical factors in avoiding overexposure. There is no doubt that many of the over 1000 workers that were temporarily or permanently suspended from working with the insecticides would have developed symptoms of organophosphate toxicity if their exposure had been allowed to continue unchecked. The provision of cholinesterase kits was perhaps one of the most cost effective ways in which USAID significantly improved the safety of the spray operations during the Project, as well as improving individual appreciation for health and environmental concerns. Cholinesterase testing kits and the provision of training in their use should become integral components of future DL control programs Agency-wide.

The environmental impact of the locust control operations could not be ascertained during the actual campaign. However, USAID-commissioned a study by the Denver Wildlife Research Center to evaluate the effects of organophosphate insecticides on ecosystems in arid environments of Morocco for future reference. According to the Final Evaluation Team, GOM officials noted that the Denver Wildlife experiments provided Moroccan biologists their first opportunity to participate in an environmental study of significant importance. This exercise provided the scientists with much needed experience in the use of sophisticated equipment, and the means to assess damage to the environment. As a measure of its impact, there is now increased awareness in Morocco for the use of pesticides that have the shorter environmental persistence.

4. POST-PROJECT MONITORING RESPONSIBILITIES

USAID activities after the PACD --June 30, 1992-- have involved the following:

- 4.1 DISBURSEMENT OF FUNDS:** Approval and processing of final payments to US and local suppliers for goods and services;
- 4.2 DEOBLIGATION OF EXCESS FUNDS:** After all consultants and suppliers have submitted their final vouchers, approximately \$272,924 dollars is expected to be available for deobligation as per Section 1311 Review.

4.3 PROPERTY ACCOUNTABILITY: All non-expendable commodities procured by the MLCP are the property of the Government of Morocco at the moment they enter the country. After the PACD, this equipment is to be used to further the objectives sought by the MLCP. Goods and services financed under the MLCP, except as A.I.D. may otherwise agree in writing, are not to be used to promote or assist foreign aid project or activity associated with or financed by a country not included in Code 935 of the A.I.D. Geographic Code Book as in effect at the time of such use. Presently, all indications are that the GOM is strictly adhering to these conditions.

4.4 POST-PROJECT MONITORING: After the PACD has passed, USAID has no continuing responsibility for monitoring DL control activities by the GOM. However, it is expected that issues raised by this document and the MLCP Final Evaluation will be used by USAID and GOM to review future locust/grasshopper control projects.

5. REVIEW OF PROJECT EVALUATIONS & FINDINGS

5.1 FINAL EVALUATION

The Morocco Locust Control Project (MLCP) evaluation was contracted to Development Assistance Corporation in collaboration with Winrock International Institute for Agriculture Development. The Final Evaluation was conducted in March 1992. A team of five experts was provided, each of whom dealt with a different aspect of the MLCP. Overall, this team was well impressed with the quality and effectiveness of the MLCP. The team concluded that the project's goal of protecting in a safe manner Moroccan crops and livestock appears to have been well-achieved in that no significant damage to crops and livestock occurred, and no reports of serious harm to human health or the environment were registered. With respect to each intended output, the teams findings were generally quite positive.

This is a general summary of recommendations contained in the Final Evaluation:

- Prior to undertaking similar DL control programs in other nations, USAID should examine the feasibility of applying the institutional structure developed in Morocco as a model for other locust control operations.
- Given the severity of the pesticide storage and disposal problem in Morocco, it is highly recommended that USAID encourage and assist the GOM in establishing a panel of representatives from concerned national and international institutions to develop a long-term, national pesticide management plan.

- In order to further assist the GOM in developing a sustained capacity to monitor and control desert locusts, USAID should encourage GOM to organize periodic workshops and training exercises to assure the transfer of experience from trained personnel to new recruits. Specific areas for training could include pesticide management and environmental monitoring.
- USAID should assure the availability of key items such as Greenness maps and cholinesterase kits for use in future control efforts.
- Efforts should continue to find protective gear more suitable for pesticide handlers under regional climatic conditions.

5.2 DENVER WILDLIFE RESEARCH CENTER STUDY

The U.S. Department of Agriculture-affiliated Denver Wildlife Research Center (DRWC) conducted a series of ecotoxicological studies on the effect of pesticides used in Morocco's locust control operations, (malathion and dichlorvos (DDVP)) in January and February of 1992. The studies were designed to evaluate the effect of these chemicals on birds, mammals and insect fauna on large experimental plots in southern Morocco. Some technical complications related to weather, experimental design and equipment malfunction were experienced by the DWRC research team which made these studies inconsistent for strict statistical analysis. The study was successful, however, in providing training and hands-on experience to Moroccan scientists in ecotoxicological research, which was one of the primary objectives of the DWRC project. In technical terms these experiments determined that:

- Malathion quickly decomposed on contact with the soil, decreasing by 85 to 90 percent after one-week;
- Residues of malathion and dichlorvos in vegetation inside treated plots were low;
- Mild physical effects were found only in one bird species (Talka swallow), but at levels not sufficient to suggest serious impairment;
- No bird or mammal mortality occurred in treated plots, and no significant effects were found affecting their numbers or normal activity in the pesticide-treated plots;
- Malathion caused extensive mortality of ants, bees, beetles and grasshoppers/locusts, while dichlorvos only affected the abundance of beetles in treated plots.

6. SUMMARY OF LESSONS LEARNED

In summary, Moroccan officials generally had a very positive view of USAID's contribution and the Agency's overall responsiveness to their requests. The Final Evaluation Team found that in meetings with GOM officials they consistently expressed gratitude to USAID for its contributions, specifically referring to the Agency's role in providing leadership and assistance in addressing environmental and health safety issues.

Based on the above analyses, and segregated according to the main outputs, the following are the principal lessons learned identified by the Final Evaluation:

Organizational Structure:

1. The structure of the National Organization that managed locust control operations proved successful, efficient and well-suited to the political, economic and social conditions in Morocco.
2. The highly disciplined organization in Morocco produced many more positive results than negative. Quick and authoritative action was especially important in Desert Locust control because of the fast and long distance movement of locust swarms.
3. After a DL threat subsided, the continued functioning of a national locust control organization has been useful in maintaining an adequate degree of preparedness.

Operations and Applications:

4. USAID-supplied aircraft and personnel worked well within the GOM organizational arrangement, and were effective in control operations. The chemical loading equipment and supplies, as well as the provision of radios, contributed greatly to the safety and efficiency of operations.
5. Although spraying with large multi-engine aircraft is often considered as overly risky in terms of potential harm to human health and the environment, their use in relatively unpopulated and non-agricultural areas should not be discounted.
6. The smaller Turbo-Thrush aircraft proved to be highly suitable for locust control due to their power, maneuverability and relatively long range. In addition, helicopters must be considered as an essential part of any DL control operation. They are valuable tools in the detection and tracking of swarms, for guidance of spray aircraft to their targets, and can be used for spray application in areas too difficult for access by fixed wing aircraft. The unique capabilities of helicopters should be exploited to the greatest degree possible and be available for early action.

7. Exhaust nozzle sprayers, though sparsely used and considered antiquated by field operations technicians, are an efficient control tool with only minimal maintenance problems-- providing a high degree of safety to the operator, and requiring very little advance training for their operation. If local acceptance of such equipment is low, measures should be taken to increase their use (i.e. training, official agreements, etc.).
8. For future locust control projects, USAID should provide funding for professional inspection services, in order to assure compliance with USAID policies on pesticide use and application. Without such inspection, and in the midst of a large control operation, it is unlikely that managers and technicians will abide by, or maintain awareness of all of the required regulations and procedures.

Survey and Control Strategies:

9. The problem of Desert Locust is highly complex. What occurs in one region will ultimately affect other regions. Therefore, the strategies and actions of individual countries will not be successful in breaking a plague. A regional cooperation approach is required. Morocco has initiated needed cooperative action with nations to the south, but much remains to be done if an effective regional plan for monitoring and controlling DL is to be developed.

Pesticide Management:

10. To avoid the potential harmful impact of unused pesticide stocks, as well as the cost of their storage and disposal, pesticides should be ordered only as needed, to the extent practicable.
11. Given problems associated with surplus pesticide stocks, a generic pesticide management plan should be developed by USAID, updated annually and made available to the Missions. This pesticide management plan should be developed for each future project in which pesticides are provided. Some of the items which should be included in such a plan are:
 - designation of storage sites, disposal sites, facilities, equipment and systems.
 - detailed description of procedures for pesticide receipt, handling, transport, storage, drum disposal, and disposition of surplus stocks.
 - on-site inspection program to ensure continuous compliance with USAID regulations.
 - a firm commitment from the host government as concerns proper disposal of any surplus or waste and empty pesticide containers in a manner consistent with AID policy.

- a procurement plan in order to keep in-country prepositioning of pesticides to a minimum.
12. In order to avoid some of the pesticide management problems which Morocco currently confronts, the following items should be noted:
- care should be taken to clearly mark pesticide containers (i.e.: with type, manufacturer, date of manufacture, expiration date, lot number, etc.).
 - as pesticide drum damage increases with each transfer from location to location, any method that reduces damage (i.e.: portable ramps, barrel hoists, etc.) must be employed.
 - while barrels are the most convenient containers for use on locust control projects, bulk shipments and returnable containers (mini-bulk) should be given preference.

Human Health and the Environment:

13. With appropriate training and frequent cholinesterase monitoring even highly toxic insecticides can be handled safely and with minimal untoward effects on the applicators. Providing cholinesterase kits proved to be a very cost-effective way for USAID to improve significantly the safety of the spray operations, and the provision of such kits should be a standard input into projects using large quantities of pesticides.
14. In locust control campaigns such as that in Morocco, it is virtually inevitable that some pesticide will enter the environment through means other than application. For instance, a certain amount of spillage on the ground appears to be unavoidable when large quantities of pesticides have to be handled for storage, formulation and transfer into application equipment. In light of this, areas where such spillage is likely to occur (i.e. formulation and transfer sites) should be well prepared to contained spills to avoid endangering ground water.
15. To the extent practical, wildlife censuses should be performed prior to large control campaigns in order to provide accurate pre-treatment counts for use in assessing environmental impact.