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SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT

REPUBLIC of INDIA

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EXECUTIVE SUMMARY

This assessment supplements the United States Programmatic Environmental Assessment (PEA) for Locust and Grasshopper Control in Africa and Asia. It provides environmental guidance in India, to allow USAID assistance in locust control. This Supplemental Environmental Assessment (SEA) is an extension of the Programmatic Environmental Assessment.

The information in this document is presented to:

1. assess the environmental and health impacts of locust and grasshopper control operations in India.

2. propose measures to ensure that significant adverse environmental and health impacts do not result from treatment of locusts and grasshoppers.

3. propose mitigation measures to reduce the impact of locust control operations to acceptable levels.

4. provide basic information to international cooperators about the Indian Locust Warning Organization and locust control programmes in India.

Information is provided on India's laws and rules that apply to pesticides. These laws and rules are: The Environment (Protection) Act; The Insecticide Act; The Air (Prevention and Control of Pollution) Act; The Water (Prevention and Control of Pollution) Act; Prevention of Food Adulteration Act; and the Wildlife (Protection) Act.

The scoping team was made up of specialists from different backgrounds. The diverse experience of the interdisciplinary team helped them identify a broad range of issues for this SEA to address.

Public input and comment was invited for the completion of this SEA. Scoping is designed to meet the requirements of USAID environmental procedures (22 CFR 216.3 (a) (4)), which describe the process to be used in preparing an environmental assessment. The base draft of this SEA was completed by a team from the Ministry of Agriculture in conjunction with USAID and FAO.

Information in this SEA concentrates on desert locust control in the states of Rajasthan and Gujarat, with additional information on the surrounding states of Punjab, Haryana or Madhya Pradesh. Desert Locust plagues have occurred 6 times in the past 100 years. The longest period of recession has been from 1962 to the present.

The Locust Warning Organization (LWO) within the Ministry of Agriculture for India is responsible for controlling desert locusts. LWO is an active member of ECLO and supports international cooperation for control of desert locusts.

This SEA identifies Integrated Pest Management as the preferred alternative for locust control, while recognizing that locust control currently relies mainly on chemicals. Non-chemical control methods are encouraged whenever possible.

This SEA identifies sensitive habitats, including major water resources, parks, wildlife sanctuaries, sensitive species habitats, and agricultural land. A summary of environmental consequences and mitigative action is presented in response to the 38 recommendations presented in the Programmatic Environmental Assessment.

A Pesticide Environmental Action Plan (PEAP) was prepared before this SEA. Details on USAID input through FAO for the 1993/1994 locust control campaign are outlined. This Action Plan forms Appendix B.

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LIST of ACRONYMS and ABBREVIATIONS

BHC	Benzine-hexachloride
CPPTI	Central Plant Protection Training Institute
ENS	Exhaust Nozzle Sprayer
FAO	Food and Agricultural Organization of the United Nations
GOI	Government of India
GPS	Global Positioning System
ha.	hectare
IPM	Integrated Pest Management
l.	liters
LWO	Locust Warning Organization (Indian)
MT	Metric ton
PEA	Programmatic Environmental Assessment
PEAP	Pesticide Environmental Action Plan
PPQS	Plant Protection, Quarantine and Storage
SEA	Supplemental Environmental Assessment
ULV	Ultra Low Volume
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency

SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT

REPUBLIC of INDIA

PURPOSE

Locust and grasshoppers outbreaks are an intermittent but persistent problem in parts of India. Most recently there has been an outbreak of the Desert Locust (*Schistocerca gregaria*) in the Thar Desert of India. This outbreak extends across the border into adjacent regions of Pakistan. The Bombay Locust (*Nomadacris (=Patanga) succinta*) and the Migratory Locust (*Locusta migratoria*) have been pests at times in other regions of India. And there are more than 100 species of grasshoppers/ locust in India that have been reported as causing damage to crops or forage (COPR, 1982).

This Supplementary Environmental Assessment (SEA) is was prepared by the Locust Warning Organization (LWO) in the Indian Ministry of Agriculture in conjunction with the US Agency for International Development (USAID) to:

1. provide a country specific assessment of the environmental and human health impacts likely to ensue from future locust and grasshopper control operations in India.

2. propose measures to ensure that significant adverse environmental and human health impacts do not result from treatment of locusts and grasshoppers.

3. propose mitigation measures, to reduce the impact of locust control operations to acceptable levels.

4. provide basic information to international cooperators about the Indian Locust Warning Organization and locust control programmes in India.

The evaluation of environmental impacts of pesticide use is an important step in locust control. Misuse of pesticides can have a disastrous impact on the environment and human health. A complete evaluation of the alternatives can balance the benefits of their use with the impacts on the environment, thus leading to a safer and more efficacious use of pesticides. USAID requires such an assessment before they can participate in an overseas programme using chemical pesticides.

This SEA has been prepared to satisfy USAID's regulatory requirements pursuant to 22 CFR 216. In 1989, USAID prepared "A Programmatic Environmental Assessment for Locust and Grasshopper

Control in Africa/Asia (PEA)" (TAMS, 1989) to assess the environmental impacts throughout the region where desert locust and other pestiferous grasshoppers have occurred. The PEA forms the basis for the preparation of this SEA. The USAID Mission (for each country that requests USAID's participation) prepares an SEA for that country. In 1993, the Republic of India through the FAO requested international cooperation for control of Desert Locust. Many countries have responded through the FAO including USAID. This SEA meets the requirements of USAID but it can also be adapted to meet the requirements set forth by other international locust control organizations.

As part of this SEA, a Pesticide Environmental Action Plan (PEAP) was prepared by USAID for participation in the 1993/94 locust campaign (APPENDIX B). The purpose of the PEAP is to ensure that USAID has acted in an environmentally responsible way in granting funds for the procurement and use of pesticides in the current locust campaign. The PEAP describes basic, internationally accepted standards and safeguards that will be in place to ensure that significant adverse environmental and human health impacts do not result from pesticide application funded under the USAID grant to FAO. These provisions fall into seven categories:

1. The procurement and use of only USAID approved pesticides;
2. The safe distribution, storage, use and disposal of pesticide containers;
3. Contractor quality control;
4. Training of all applicators (both aerial and ground);
5. Notification of affected communities vis-a-vis spraying plans and precautions;
6. Avoidance of spraying human settlements, ecologically sensitive areas, protected areas and the habitats of important species;
7. Monitoring of pesticide use and effectiveness.

SUMMARY OF INDIAN ENVIRONMENTAL AND PESTICIDE REGULATIONS

There are many regulations and laws in India that apply to the use of pesticides and protection of the environment. These include: The Environment (Protection) Act, 1986; The Wildlife Protection Act, 1974; The Insecticides Act, 1968; The Air (Prevention and Control of Pollution) Act 1981; The Water (Prevention and Control of Pollution) Act 1974; and the Prevention of Food Adulteration Act, 1954.

The Environment (Protection) Act, 1986.

In India an Act known as the Environment (Protection) Act, was promulgated in 1986 to provide for the protection and improvement of the environment and connected matters. The major

activities are:

(i) Coordination of action by the State Government's officers and others under this Act, or the rules made thereunder; or under any other law for the time being in force which is relatable to the objects of this Act;

(ii) planning and execution of a nationwide programme for the prevention, control and abatement of environmental pollution;

(iii) laying down standards for the quality of environment in its various aspects;

(iv) laying down standards for the emission or discharge of environmental pollutants from various sources whatsoever; provided that different standards for emission or discharge may be laid down under this clause from different sources having regard to the quality or composition of the emission or discharge of environmental pollutants from such sources;

(v) restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards;

(vi) laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution and remedial measures for such accidents;

(vii) laying down procedures and safeguards for the handling of hazardous substances;

(viii) examination of such manufacturing processes, materials and substances, as are likely to cause environmental pollution;

(ix) carrying out and sponsoring investigations and research relating to the problems of environmental pollution;

(x) inspection of any premises, plant, equipment, machinery, manufacturing or other processes, material or substances and giving, by order, of such directions to such authorities officers of persons as it may consider necessary to take steps for the prevention, control and abatement of environmental pollution;

(xi) establishment or recognition of environmental laboratories and such institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act;

(xii) Collection and dissemination of information in respect of matters relating to environmental pollution;

(xiii) preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution;

(xiv) such other matters as the central Government deems necessary or expedient for the purpose of securing the effective implementation of the provisions of the Act.

The Insecticides Act, 1968.

The word "pesticides" includes insecticides, fungicides, nematicides, and herbicides. This legislation has been termed as "The Insecticides Act, 1968", but it does not mean that the legislation only regulates insecticides. This Act was passed in 1968 to regulate the import, manufacture, sale, transport, distribution and use of pesticides to prevent risks to human beings or animals. This Act extends to all of India. Under this Act, all pesticides are registered only after being tested for efficacy and for safety to human beings, animals and the environment. It also regulates pesticide manufacture, sale, and distribution through a licensing system. In other words no pesticide can be imported/manufactured in India for use unless it is registered by the Registration Committee under the above said Act.

The Air (Prevention and Control of Pollution) Act, 1981:

This Act was promulgated in 1981 for the prevention, control and abatement of air pollution and for the establishment of the Board to carry this out. Under this Act, a Central Pollution Control Board and State Pollution Control Board have been constituted. State Air laboratories have been set up to analyze air samples.

The Water (Prevention and control of Pollution) Act, 1974:

This is an Act to provide for the prevention and control of water pollution and maintaining or restoring of wholesomeness of water and for the establishment of the Boards for the prevention and control of water pollution with a view to carrying out the aforesaid purpose. Under the statute, Central and State Boards test samples of effluent, report the analysis, prohibit the use of stream or wells for the disposal of decaying matter, and restrict new disposal outlets.

Prevention of Food Adulteration Act, 1954:

The Prevention of Food Adulteration Act, 1954, prevents the adulteration or mixing of other substances in food. This Act

establishes the maximum permissible limit of certain food additives and extraneous matter including pesticides.

Indian Wildlife (Protection) Act, 1972 amended 1991:

The Indian Wildlife (Protection) Act was enacted to unify legislation previously under the authority of each state. The Act:

1. Protects wildlife and punishes violations.

2. Provides that any person who has evidence of an offence against this act can give notice to the Chief Wildlife Warden.

3. Prohibits hunting of all wildlife listed in Schedules I, II, III and IV.

4. Provides that commercial inventories of wildlife articles will be verified and stamped.

5. Bans commercial felling and exploitation of wildlife in wildlife sanctuaries and national parks.

6. Regulates hunting licenses near parks and wildlife sanctuaries.

7. Provides for seizure of vehicles, weapons, etc used for committing offenses.

8. Prohibits trade in imported ivory.

9. Bans transport of regulated articles.

10. Bans export of all birds.

11. Provides for setting up of the zoo authority.

12. Lists species for protection under Schedules I, II, III, IV and V.

SCOPING PROCEDURES

This SEA deals with locust and grasshopper control. It is concerned with the control of Desert Locust in particular and in general with the control of other species of grasshoppers and locusts which affect the environment including wildlife, crops, livestock, and human health. It examines the effects of certain major insecticides in use and others which are being tested by international organizations. It considers the requirements for technical assistance from major donors organizations and the international and national plant protection agencies with respect

to control of Desert Locust and the inevitable effect of insecticides on the environment of India. It looks into the historical and current locust situation in India. Strategies will be designed to control locusts on a short and long term basis as well as on a national and international basis. The plan will be checked for the availability of pesticides, manpower, pest surveying, and equipment.

Due to the complex nature of these issues, the scoping is being carried out by an interdisciplinary team. Diverse backgrounds and experiences help the scoping team identify issues and alternatives in locust control. Public input and comment is invited for the completion of this SEA. Scoping is designed to meet the requirements of USAID environmental procedures (22 CFR 216.3 (a) (4)), which describe the preparation of an environmental assessment. This SEA was prepared by the Indian Ministry of Agriculture in conjunction with USAID and FAO. The team was selected by Dr. V. Ragunathan, Plant Protection Advisor to the GOI. The team consisted of: Dr. Brajendra Singh, Entomologist; Dr. Salish Chandra, Deputy Director Locust Control, Dr. D. Kanungo, Joint Director and Head Division of Medical Toxicology; Dr. M. L. Saini, Joint Director and Head Bioassay Division and consultant to USAID, Timothy J. McNary, Entomologist, US Department of Agriculture.

DESCRIPTION OF THE AFFECTED ENVIRONMENT

Region included in SEA:

India is at the eastern limits of the range of the desert locust. Recession populations do not extend east of the Rajasthan desert. Only during plagues have populations expanded and swarmed throughout India. The primary area of concern is the desert regions of the states of Gujarat and Rajasthan. The vast majority of control operations will occur here. On occasion escaped swarms must be treated in the states of Haryana, Punjab, and Madhya Pradesh. This SEA concentrates on Gujarat and Rajasthan, and to a lesser extent on Punjab, Haryana and Madhya Pradesh.

History of Desert Locust in India:

Locust breeding is a regular seasonal activity in the desert region of India. Occasionally, populations reach epidemic proportions and attack valuable vegetation and crops. Plagues can arise within India or invade from outside the borders.

In India, there were 4 plague cycles during the second half of the 19th century:

(i) 1863-1867.
(ii) 1869-1873.
(iii) 1876-1881.

(iv) 1889-1898.

In the present century, there have so far been 6 distinct plague cycles:

(i) 1900-1907.
(ii) 1912-1920.
(iii) 1926-1931.
(iv) 1940-1946.
(v) 1949-1955.
(vi) 1959-1962.

Damage caused by locust during the plague cycle of 1926-31, 1940-46, 1949-55 and 1959-62 were worth Rs. 10 crores, Rs. 2 crores, Rs. 2 crores and Rs. 50 lakhs respectively. (1 crore=10,000,000 Rs, 1 lakh=100,000 Rs.)

In India , the locust plagues have been in check from 1963 onward due to insecticidal treatments of swarms and hoppers bands as they develop. But seasonal upsurges erupted in 1964, 1968, 1970, 1973, 1974, 1976, 1978, 1982, 1983, 1986 and 1988-89.

Development of 1993 Locust Upsurge:

Locusts tend to move down wind which brings them into areas with recent rainfall. After breeding and with the onset of the dry seasons they migrate to complementary breeding areas where rainfall has occurred for further breeding. The main breeding season in India is the Summer Breeding in July through October. Winter and Spring Breeding normally occurs outside of India.

A recent locust upsurge in the Red Sea areas of Saudi Arabia, Sudan, and Yemen in late 1992 and spring of 1993 is one of the reasons for the 1993 locust situation in India. Despite control operations in these countries, a sizable locust population escaped to neighboring countries during May and June 1993 and arrived in India in July. Due to favorable wind movements from the southwest during the monsoon, swarms were carried into Gujarat and Rajasthan during the first week of July 1993.

The first wave of locust swarm incursions from the south and west continued throughout July and early August. A total of 62 yellow fully mature swarms entered the districts of Barmer, Jaisalmer, Bikaner in Rajasthan and Banaskantha and Kutch Districts in Gujarat. The wide spread and unprecedented rains in the desert areas of Rajasthan and Gujarat provided ideal environmental conditions for breeding and egg laying. Much egg laying from these first incursions was completed before swarms could be neutralized by ground and aerial application of pesticides.

During the second wave massive swarm incursions started

around the 23rd of August. Over 106 pink swarms entered the country by the end of September. These swarms were controlled by aerial and ground operations. Some egg laying occurred in areas of Barmer, Bikaner, Churu, Jodhpur, Nagaur and Sikar before adults could be neutralized. Hopper emergence was noticed in 106 locations since the 21st of September and these were also controlled effectively by ground control operations.

A smaller third wave entered from the west during the first week of October entering the districts of Banaskantha and Kutch in Gujarat and the Bikaner district in Rajasthan due to westerly winds. During October a total of 8 swarms were found and treated. Some of the swarms escaped to districts of adjoining Banaskantha and were also controlled. Swarms that entered Bikaner were controlled by ground and aerial operations. One small swarmlet escaped toward Sriganganagar and adjoining areas of Haryana where it was treated and controlled. Swarmlets also migrated from the Bikaner area to Alwar and Sawaimadhopur where they were controlled by ground and aerial operations. Erratic wind patterns also carried a swarmlet to the Ujjain and Mandsaur district of Madhya Pradesh. Arrangements were made to position aircraft at Ujjain to neutralize these swarmlets. Mopping up operation are currently in progress (28 Oct 1993). The locations of swarms is shown in Figure 1 and 2. The swarm incursions and wind patterns were monitored and daily situation maps were produced (Figures 3, 4, 5 and 6).

This upsurge in the desert locust situation quickly overran the capabilities of the staff and equipment of the LWO. Temporary staff and equipment were supplied by the GOI and by international locust control organizations. The resources available during the 1993 season are summarized in Table 1:

Table 1. Resources Available During the 1993 Locust Campaign.

RESOURCE	Numbers available on 1 July 1993	Numbers augmented from outside LWO
Manpower	329	317
Physician on duty	none	1
Wireless Sets	71	41 on loan
Vehicles	106	89 on loan
Hand Dusters	5881	1500
Power Dusters	105	50
Exhaust Nozzle Sprayers	22	none
ULV Hand Sprayers	17	125
ULVA-MAST Sprayers	none	8
Application helicopters	none	3 hired
Application airplanes	none	2 hired
BHC 10% Dust	1014 MT	500 MT
BHC Technical	35 MT	none
Dieldrin 18 %	49 MT	none
Dieldrin technical	35 MT	none
Fenithrothion ULV	28 MT	20.2 MT
Malathion	2 MT	50 MT

Structure of Ministry of Agriculture as related to locust control:

Within the Indian Ministry of Agriculture is the Directorate of Plant Protection, Quarantine and Storage located at Faridabad (30 km south of New Delhi). Dr. V. Ragunathan is the Plant Protection Adviser to the Government of India and the Director for Locust Control. The Locust Warning Organization is headquartered in Faridabad (Haryana State) and was created in 1939 with the primary objective of monitoring locust activities over 200,000 square kilometers of scheduled desert (Thar Desert) area and undertaking control operations whenever required. It has 4 circle offices at Jodhpur, Barmer, Bikaner and Palanpur and

24 outposts located in remote areas (Figure 7). The field headquarters is at Jodhpur. Control potential in the form of manpower, vehicles, pesticides, wireless sets etc. is maintained at each field outpost for operations. In addition, there is a Field Station for Investigations on Locust located at Bikaner to carry out field studies on biology, ecology, behavior and control of locusts and arid zone grasshoppers. A remote sensing laboratory has been set up at Jodhpur to use satellite data for improving locust surveillance and forecasting. Offices of the Directorate of PPQS at Faridabad are the Central Insecticides Laboratory, IPM, Plant Quarantine and Fumigation, and the Registration (of pesticides) Secretariat.

The major functions of the LWO are:

1) Locust monitoring and control in Scheduled Desert Area.
2) Warning the State functionaries and farmers.
3) Training the State functionaries and farmers.
4) Preparing vegetation maps based on satellite imagery for locust forecasting.
5) Discharging international obligations in locust control.
6) Conducting field investigations on locust behavior, ecology, biology and control.

Agricultural land uses:

The desert region of Rajasthan is used primarily for grazing livestock and oasis style farming. The region outside the desert is an important farming area. Potential locust invasions originating in the desert would be disasters for the farmers. A summary of the land used for crops is presented in Table 2:

Table 2. Crops in Northwest India.

	Punjab	Rajasthan	Haryana	Gujarat	Madhya Pradesh
M HA cultivated	5.68	12.64	4.07	4.62	17.25
% area cultivated	4.5%	9.9%	3.2%	3.6%	13.9%
Rice M Ha	2.2	-	0.67	-	5.0
Wheat M Ha	3.2	1.8	1.85	0.72	3.74
Other Cereals M Ha	0.24	7.02	0.82	2.44	4.15
Pulses M Ha	-	3.69	0.73	0.93	4.80
Oilseed M Ha	-	3.08	-	2.71	3.77
Cotton M Ha	0.70	0.45	0.49	0.92	0.59
Sugarcan M Ha	0.10	-	0.15	0.12	-

Livestock:

Livestock production is very important to the economy of the states in northwest India. Much of the region is covered in grasslands suitable for grazing. If good rains occur in the desert grass will grow, providing forage for the livestock. Cows, sheep, goats, water buffalo and camels are pastured in the region. Livestock is important for transportation, wool, milk and meat. Dried manure is used for fuel and fertilizer.

Honeybees and other pollinators:

In some areas of Rajasthan, rape and mustard seed are grown during the rainy season. These crops are cross pollinated in nature by insects. Honey bees play an important role in pollinating these crops. There are three species of honey bees prevalent in India. These are *Apis dorsata, A. indica* and *A. florea.*

In order to save honey bees and other pollinators of rape and mustard crops, it is best to avoid the use of chemical pesticides for control of locust in these areas. Besides affecting pollinators, insecticides can also leave residues in the oil seed. In cases where pesticides have to be used for control of locust on crops only those insecticides registered for use by the GOI on that crop will be used.

Water Resources:

Desert locusts usually breed in deserts where there is little water. Keeping water clean and uncontaminated in a desert is very important because water is so scarce. The states in India where locust control is most likely are a desert region, but there are many important water resources in the region. The major water resources are summarized in the following paragraphs.

Rajasthan: This State has 3 major rivers, namely the Luni, Banas and Chambal. These rivers are perennial in nature. The Luni river waters the southern parts of Rajasthan whereas the Chambal River flows between Rajasthan and Madhya Pradesh. Tributaries of the Chambal originate from the slopes of Aravalli in Udaipur District. There are 5 salt water lakes in Rajasthan; the Samphar (Udaipur Dist.), Deedwana (Nagore Dist.),Lukransar (Bikaner Dist.), Bachpastra (Barmer Dist.) and Phalodi (Jodhpur Dist.). There are 15 sweet water lakes; Jaisamad (Udaipur Dist.), Raj Samand (Udaipur Dist.), Pichola (Udaipur Dist.), Udaisagar (Udaipur Dist.), Fatehsagar (Udaipur Dist.), Anasagar (Ajmer Dist.), Phaisagar (Ajmer Dist.), Pushkar Lake (Ajmer Dist.), Balsamand (Jodhpur Dist.), Gaipsagar (Dungpur Dist.), Salisand (Alluwar Dist.), Kailana (Jodhpur Dist.), Nakhi Lake (Sirohi Dist.), Naulakah (Bundi Dist.) and Kolyat (Bikaner Dist.).

Apart from these there are a number of small man-made water reservoirs throughout Rajasthan used for providing the water to small hutments. The northwestern side of Rajasthan is irrigated by the Rajasthan Canal.

Gujarat: There are 10 major rivers in Gujarat; the Banas, Saraswati, Sabarmati, Mahi, Dhadhar, Narmada, Ambiga, Purna, Tapi and Auranga Rivers. Out of these 10 rivers only 3 rivers are perennial, the Mahi, Narmada and Tapi. There are 4 large lakes, Gheds Lake (Madhupur Dist.), Narayan Sarover (Kachchh Dist.), Mehad Lake (western Gujarat) and Nal Sarover (Ahmedabad Dist.). Major estuaries are located in the Rann of Kutch and at the head of the Gulf of Kutch.

Apart from these there are numerous small temporary water sources in the form of wells and small ponds. The southwest of Gujarat borders the Arabian Sea.

Punjab: There are 3 main rivers in Punjab. They are the Sutlej, Ravi and Beas. The Yamuna river forms the eastern boundary of Punjab. There are many man-made reservoirs that hold water for irrigation. Major Reservoirs are the Bakranangal Dam, Harika Barrage, Pond Dam and Madhavpur Barrage. Much of the area receives water via irrigation canals, the major canal are the Bakra Canal, Siehind Feeder Canal, Madhupur-Beas Link Canal and the Sutlej-Beas Link Canal. There are also numerous smaller reservoirs, ponds and wells throughout Punjab.

Haryana: The Yamuna River marks the eastern border of Haryana. There are not any other perennial rivers. There are 4 main lakes, the Badhkal, Karnal, Suraj Kund and Sohna Lakes. Many other smaller ponds, reservoir and wells are found throughout Haryana.

Madhya Pradesh: There are 14 major rivers in this state. They are the Betwa, Sone, Jamani, Champal, Tapti, Ganga, Mahanadi, Godawari, Yamuna, Hasdeo, Wain Ganga, Tawa, Tons and Indravati Rivers. There are also numerous lakes, reservoirs and other water resources throughout Madhya Pradesh.

Cities and towns:

National Parks and Wildlife Sanctuaries:

Rajasthan,
Table 3. National Parks In Rajasthan.

1.	Keoladeo Ghana	Bharatpur District	28.73ha
2.	Ranthambore Tiger Res.	Sawai Manhopur	392.00
3.	Sariska Tiger Res.	Alwar	273.80
4.	Desert National Park	Jaisalmer	3162.00

Table 4. Wildlife Sanctuaries in Rajasthan.

1.	Banda Baratha	Bharatpur District	92.76ha
2.	Bassi	Chittorgarh	152.00
3.	Bhensroadgarh	Chittorgarh	229.14
4.	Darrah	Kota	265.03
5.	Desert	Jaisalmer	3162.00
6.	Jaisanand	Udaipur	52.00
7.	Jamwa Ramgarh	Jaipur	300.00
8.	Jawahar Sagar	Kota	100.00
9.	Keladevi	Sawai Hadhopur	676.38
10.	Kumbhalgarh	Udaipur	678.25
11.	Mt. Abu	Sirohi	288.84
12.	Nahargarh	Jaipur	50.00
13.	National Chambal	Kota	280.00
14.	Phulwati	Udaipur & Pali	511.41
15.	Ramgarh Visdhari	Bundi	307.00
16.	Sariska	Alwar	492.00
17.	Sajjangarh	Udaipur	5.19
18.	Shergarh	Kota	98.71
19.	Sita Mata	Chittorgarh	422.94
20.	Sawai Mansingh	Sawai Madhopur	103.25
21.	Sunda Mata	Sawai Madhopur	107.00
22.	Tal Chapper	Churu	7.90
23.	Todgarh Rawali	Ajmer	405.27
24.	Van Vihar	Dholpur	59.93

Haryana, sanctuaries include the Sultan Thur Bird Sanctuary near Delhi.

Punjab,

Gujarat, the Lion Sanctuary at Gir Forest and the Anjar Wild Ass Sanctuary are the only major protected areas.

Madhya Pradesh, has several important National Park. These include Kanha NP, Panna NP, Bandhavgarh NP and Satpula NP.

The locations of major National Parks and Wildlife Sanctuaries in relation to the area where locust control is expected is shown in Figures 8 through 11.

Endangered and other Sensitive Species:

India has a particularly diverse native flora and fauna within its borders. Many of these have become endangered because of habitat loss, over-hunting, misuse of pesticides and many other factors. In order to protect these species India enacted the Wildlife (Protection) Act, 1972, amended 1991. As part of this act, five Schedules were created, listing species for protection. Species in Schedule I, II, III, and IV are protected

from all hunting. In addition this act protects all species within any wildlife sanctuary or National Park. Many animals on these list can be found with in the region covered by this SEA (Nair, 1992). A summary of species listed in Schedule I, the most threatened species, follows:

Tiger, *Panthera tigris*

The tiger was once found throughout the jungles and scrub forest in India, but due to hunting and conflicts with humans its populations are now restricted to 19 wildlife sanctuaries in India. Since it became a protected species its numbers have increased from 1827 to over 4000 individuals. The Sariska Wildlife Sanctuary and Rathambore Wildlife Sanctuary are the only sanctuaries in the region covered by this SEA that have a resident tiger population.

Tigers would not be threaten directly by treatments of the pesticides used for desert locust control, but because they are a carnivore (known to feed on locust at times) there is a potential for bioaccumulation of persistent pesticides such as Dieldrin and BHC. Malathion and fenithrothion have a very low potential for bioaccumulation.

Asiatic lion, *Panthera leo persica*

The Asiatic lion is only found in the Gir Forest National Park in Gujarat. They have been protected since 1907 when only 13 were known to exist. Now the population is over 200. Dieldrin and BHC have a potential to bioaccumulate in lions.

Leopard, *Panthera pardus*

Leopards in India are known to inhabit the semidesert regions of the northwest. Here they could act as bioaccumulaters of persistent pesticides.

Leopard Cat, *Felis bengalensis*

The leopard cat (because it prefers denser forest than the lion, tiger or leopard) is less likely to be affected by pesticides.

Indian Desert Cat, *Felis silvestris ornata*

The Indian desert cat is the size of a house cat. It lives through out the dry areas in Rajasthan and Rann of Kutch. Extensive killing for its fur has made this species very rare and endangered. It feeds on small mammals and birds, but also may feed on insects including locusts. Because its prey would likely come in contact with pesticides, persistent pesticides such as dieldrin and BHC could bioaccumulate in their body tissue. Malathion and fenithrothion do not have this potential.

Caracal Cat, *Felis caracal schmitzi*

The caracal inhabits the arid and semiarid regions of northwest India. This cat is slightly larger than a house cat, has a short tail and long pointed ears. It feeds on birds and

small mammals. The persistent pesticides, dieldrin and BHC could bioaccumulate in this species.

Wolf, *Canus lupis pallipes*

Small groups of wolves can be found in Rajasthan, Gujarat and other regions of India. The main threat to wolves is hunting but bioaccumulation of persistent pesticides could present a risk to their populations.

Desert fox, *Vulpes benegalensis*

The desert fox inhabits the forest scrub and agricultural fields of India. This fox feed on small mammals, reptiles, insects and fruits. Hunting as well as excessive use of pesticides have greatly reduced its population. Use of malathion and fenithrothion for locust control would not threaten the fox.

Indian Pangolin, *Manis crassicaudata*

The pangolin, also known as the scaly ant-eater, lives in the plains and foothill of India. They feed on ants and termites. Hunting of these animals and habitat destruction are primarily responsible for the decline in its populations.

Asiatic Wild Ass, *Asinus hemionus khur*

The Asiatic wild ass was at one time found throughout the states of Gujarat and Rajasthan. At present it is know only from the Rann of Kutch where a small population survives at the Wild Ass Sanctuary. Pesticides as used for control of desert locust do not threaten this animal. Competition from domestic livestock for forage is the major factor responsible for its decline.

Blackbuck, *Antilope cervicapra*

The blackbuck can be found in small herds, up to 10 animals, in the states of Rajasthan, Gujarat, and other regions in India. Most now survive in wildlife sanctuaries or National Parks. In the Khejarli area of Rajasthan, due to its protection, it can be seen roaming freely amidst human habitation. Pesticides, when used properly for desert locust control, do not present a danger to this species.

Crocodiles

All species of crocodiles are protected in India. They have become rare in the rivers and estuaries of India. Conflicts with pesticides used for desert locust could occur in the Rann of Kutch when the region become flooded by monsoonal rains and high tides. But the actual potential hazards of pesticides to crocodiles has not been investigated in India.

Great Indian Bustard, *Ardeotis nigriceps*

Once distributed through the drier regions of India the great Indian bustard is now restricted to parts of Rajasthan and Gujarat. The major threat to its survival has been habitat destruction and hunting. It is unlikely that pesticides used in

locust control would have a significant adverse impact on this species. Another species, the Houbara Bustard, is a winter resident that is not in the region at the time of year when locust control activities are in progress.

Butterflies,

Many species of butterflies are protected under the Wildlife (Protection) Act. Most of these occur in eastern India and are threaten by pesticides and collectors. It is not known if any of these occur where desert locust control is likely. Pesticides could impact butterflies and other non-target insects.

Four plant species protected in the states of Rajasthan and Gujarat by the Indian Institute of Ecology and Environment (Kumar, no date) are:

Commiphora wightii	Burseraceae
Helichrysum cutchicum	Asteraceae
Hyphaene dichotoma	Arecaceae
Rosa involucrata	Rosaceae

The exact status of these species is unknown at this time. It is unlikely that locust control programs would contribute to their decline. On the contrary, locusts eat these plants, so controlling locusts could help protect these plant species.

Species Occurring in India found on the U.S. Fish and Wildlife Service list of endangered and threatened wildlife and plants (50 CFR 17.11 and 17.12) are:

Common Name	Scientific name	Status
	BIRDS	
Duck, pink-headed	Rhodonessa caryophyllacea	E
Duck, white-winged wood	Cairina scutulata	E
Pheaseant, Blyth's tragopan	Tragopan blythii	E
Pheasant, cheer	Catreus wallochii	E
Pheasant, Sclater's monal	Lophophorus sclateri	E
Pheasant, white eared	Crossoptilon	E
	REPTILES	
Gavial	Gavialis gangeticus	E
Monitor, Bengal	Varanus bengalensis	E
Monitor, desert	Varanus griseus	E
Python, Indian	Python molurus	E
Turtle, Indian softshell	Trionyx gangeticus	E
Turtle, peacock softshell	Trionyx hurum	E
Turtle, three-keeled	Melanochelys tricarinata	E

MAMMALS

Cat, leopard	Felis bengalensis	E
Deer, Eld's brow-antlered	Cervus eldi	E
Deer, swamp	Cervus duvauceli	E
Hare, hispid	Caprolagus hispidus	E
Hog, pygmy	Sus salvanius	E
Langur, capped	Presbytis pileata	E
Langur, entellus	Presbytis entellus	E
Langur, golden	Presbytis geei	E
Leopard	Panthera pardus	E
Lion, Asiatic	Panthera leo persica	E
Macaque, lion-tailed	Macaca silenus	E
Macaque, stump-tailed	Macaca arctoides	T
Rhinocerus, great Indian	Rhinocerus unicornus	E
Tiger	Panthera tigris	E
Yak, wild	Bos grunniens mutus	E

BHC and dieldrin, persistent pesticides with the potential for bioaccumulation, have the greatest potential to affect endangered and sensitive species in India. BHC and dieldrin are approved by the Government of India (GOI) for desert locust control, but dieldrin is only approved by GOI until existing stocks are used up. Using less persistent pesticides, i.e. malathion and fenithrothion will significantly decrease the risk to endangered species. Fenitrothion is generally more toxic than dieldrin to aquatic invertebrates; however, no pesticides should be applied within 5 km of an aquatic habitat. Fenitrothion also bioaccumulates more readily than malathion, and is generally more toxic to birds than malathion. Both malathion and fenitrothion have relatively low toxicity to mammals. If malathion is heated, however, its toxicity to mammals increases. Of BHC, dieldrin, fenitrothion, and malathion, it is malathion that would have the least impact on endangered and threatened species.

To reduce the impact of locust control operations on endangered species, this SEA recommends:
1) only using less persistent pesticides (e.g. malathion or fenitrothion);
2) avoid applying pesticides to critical habitats.

ALTERNATIVES FOR CONTROL OF LOCUST AND GRASSHOPPERS

Five alternatives are considered for control of locust in the PEA prepared by USAID. These are

Alternative A. No control measures and mitigative actions.
Alternative B. Non-Chemical control only.
Alternative C. Chemical control only.
Alternative D. Biological control.
Alternative E. Integrated Pest Management (IPM).

The GOI could choose a method of locust control other than those approved by USAID, as long as no USAID funds are commingled with

the use of pesticides not approved by USAID.

Alternative A. No control measures and mitigative actions

Under this alternative, no control activities would occur. The natural population cycles of desert locust would be allowed to run their course, with periods of outbreaks and plagues followed by periods of recession. During plague years extensive damage to crops would occur. Allowing plagues to develop and persist would have international implications for the Middle East and Africa. Plagues starting in India have historically spread to the Middle East and Africa. More accurate locust and weather forecasting could allow the no-treatment option in areas where there is no potential for crop damage or swarm development, but this is very risky.

USAID or any donor has the option to independently support locust control in India. Although these organization have no legal obligation to participate in locust control programmes, it is within their mandate to help find solutions to locust problems. Only international organizations can coordinate a regional response to locust outbreaks. International organizations foster information exchange, monitor outbreaks, provide technical assistance, and allocate resources. Desert locust control requires international cooperation for successful control or prevention of outbreaks and India's location at the tail end of traditional locust infested areas necessitates India's active involvement. India is a member of ECLO (Emergency Center Locust Operations).

Lack of USAID or FAO participation could have a major detrimental impact on the way in which future international locust control programmes are conducted. FAO and USAID have been instrumental in updating technologies used in locust control and in securing the elimination of environmentally undesirable pesticides like dieldrin and BHC. GOI is phasing out the use of these chemicals.

Alternative B. Non-Chemical control only.

At the present time there are few non-chemical control methods that would be effective against a major upsurge of locusts. Farmers in India are using the technique of driving small hopper bands into trenches and burying them. (This technique is also being used in conjunction with BHC dust.) Adult locust swarmlets can be harassed to leave a particular area, but this only moves the problem to somewhere else and does nothing to prevent plague development. Egg beds can be mechanically destroyed. All these methods can be used for small scale local control of locust. They would be unsuccessful in controlling or preventing a major outbreak.

On a long term basis research needs to continue on non-chemical control of locusts. Acridid resistant crop varieties with antifeedant characteristics may be identified. Improved pest forecasting to a degree would allow more effective employment of certain non-chemical measures. Farmers might choose a resistant crop variety or alter planting dates when heavy infestations are forecast for the coming season.

Non-chemical controls alone do not offer the prospect of effective locust control.

Alternative C. Chemical control only.

India has four chemical pesticides registered for control of desert locust. These are malathion, fenithrothion, BHC and dieldrin. All of these pesticides have been used successfully in locust control in India, but none are without risks to health or the environment. USAID and FAO have approved other pesticides for locust control but these could not be used in India unless necessary data is supplied for their registration and use. The approved pesticides are summarized in Table 3. Dieldrin and BHC have been removed from the approved insecticide list of FAO and USAID. These pesticides can not be used in programmes supported by USAID funds, unless USAID is assured that no USAID funds are used for (or commingled with) programme activities involving dieldrin or BHC. Such assurances can be detailed in a Pesticide Environmental Action Plan (PEAP).

Table 3. Governmental Approval for Pesticides used Against Desert Locust in India.

PESTICIDE	USAID APPROVED	FAO APPROVED	GOI APPROVED
Malathion	Yes	Yes	Yes
Fenitrothion	Yes	Yes	Yes
Bendiocarb	Yes	Yes	No
Chlorpyrifos	Yes	Yes	No
Diazinon	Yes	Yes	No
Lambda-Cyhalothrin	Yes	Yes	No
Acephate	Yes	No	No
Carbaryl	Yes	No	No
Tralomethrin	Yes	No	No
BHC (10% Dust)*	No	No	Yes*
Dieldrin**	No	No	Yes**

*Restricted use pesticide
**Outlawed in India, except to use existing supplies to control desert locust in scheduled desert areas.

Malathion and fenithrothion for locust control are used as a ULV spray application in India. They can be applied by aircraft, helicopters, vehicle mounted applicators or hand held ULV

applicators. Malathion is manufactured in India and is locally available.

Dieldrin is currently being used for locust control in remote regions of the desert. It was originally supplied by donor agencies in the 1960's for locust control. Its use and manufacture is banned in India except for using existing stocks. It was decided by the GOI that this was the best alternative for its disposal. It is normally used with vehicle mounted Exhaust Nozzle Sprayers (ENS).

BHC is used as a dust in India. India restricts its use to non-crop areas. Its major use has been to control hopper bands.

Alternative D. Biological control.

Biological control is the use of predators, parasitoids, and pathogens to suppress pest populations. There are currently no effective means of biological control of locusts. *Nosema locustae,* a species of microsporidia, has been used with only limited success in the US. Experimentation continues on the augmentation of parasitoids and diseases in other countries. The importation of exotic diseases and parasitoids for control of native grasshoppers has recently been halted in the US until further evaluation of the impacts is completed.

USAID, the Swiss Development Cooperation (SDC), the Overseas Development Agency (ODA), the Directorate General for International Cooperation of the Netherlands (DGIC) and CIDA have funded research on the biological control of locusts and grasshoppers. Research has led to the development of a formulation of the entomopathogenic fungi *Metarhizium flavoviride* that kills locusts and grasshoppers, but has no known effects on other organism. The fungal spores have been formulated in oil and would not require dilution in water in the field. The spray can be prepared by local personnel using locally available resources. The mass rearing of the fungal spores in completed in a laboratory. Promising field trials have been completed in Benin, Niger and Mali, resulting in effective control of grasshopper after 10 days. A field trial was attempted in Pakistan in 1993 with unknown results because the hoppers became adults and flew off before results could be recorded. Further experimentation is planned for Mauritania and needs to be completed in other countries against desert locust before it can be recommended for control programs. CIDA has also completed similar trials with *Beauvaria bassiana*. The production technologies are not as developed as for *M. flavoviride*. If efficacy is demonstrated, this fungi could also be used in the management of locust.

Alternative E. Integrated Pest Management (IPM).

IPM could involve combinations of any of the previously described alternatives for safe and effective prevention and control of desert locust. Currently, locust control relies heavily on chemical pesticides. IPM does stress minimizing toxic pesticide applications through the use of survey and forecasting, plague prevention, and selection of pesticides least likely to have non-target effects.

THE SELECTED ALTERNATIVE

India has adopted IPM as its primary strategy for crop protection including the control of locust. USAID has chosen the Integrated Pest Management alternative realizing that it still depends heavily on chemical pesticides. In India this would involve using malathion or fenithrothion to control swarms and hopper bands in the desert areas to prevent plague development and invasion of croplands. Early intervention in breeding areas will decrease the quantity of pesticide required if a plague situation was permitted to develop. Training of the LWO staff on safe and effective use of pesticides is proposed. No USAID granted funds are permitted to be commingled with programmes involving the use of dieldrin or BHC or any other pesticide not on the USAID approved list. Non-chemical means will be encouraged where ever possible. Forecasting and prevention of plague outbreaks on an international basis is emphasized. India is an active member of ECLO. Research on new technologies for reducing or eliminating use of chemical pesticides will be supported.

ENVIRONMENTAL CONSEQUENCES, AND MITIGATIVE ACTIONS

In the PEA prepared by USAID, 38 recommendations are presented that will decrease the environmental consequences and provide mitigative actions for use during locust campaigns. This section summarizes the action under these recommendations as they apply to locust control in India.

Recommendation 1. It is recommended that USAID continue its involvement in locust and grasshopper control. Operationally, the approach to be adapted should evolve toward one of IPM.

The GOI supports the IPM concept in locust control in India. The GOI has requested assistance for improving its application technologies to reduce chemical use and to use pesticides in a safe and effective manner. Research is continuing in India on the use of antifeedants. Dieldrin use will be stopped when existing stocks are exhausted. Converting to ULV application and eliminating Exhaust Nozzle Sprayers is an objective of the LWO.

Recommendation 2. It is recommended that an inventory and mapping program be started to determine the

extent and boundaries of environmentally fragile areas.

USAID supports any effort by the LWO to identify any environmentally sensitive area in the regions where locust control is likely in India. This would include identification and mapping of National Parks, Wildlife Sanctuaries, water resources, ranges of endangered species, etc. This SEA is the first organized attempt by the LWO to identify these areas.

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

Chemicals should only be purchased as needed. USAID would support the creation of pesticide banks or delivery-on-need contracts through the FAO.

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

The LWO in India still uses Dieldrin for locust control. Its use and manufacture is banned in India except to use up existing stocks. The LWO would welcome assistance with finding alternatives to the use and disposal of this pesticide.

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

The LWO supports this idea and would contribute information to such an inventory. Locust control and plague prevention must be coordinated on an international level to be effective.

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

Existing legislation in India does not permit the application of chemical pesticides in sensitive area or where harm to human health is likely. The LWO of India will not treat for locust in National Parks or Wildlife Sanctuaries. Swarms settling in inhabited area, towns or villages will be harassed to leave the area before being treated. Treatments will not be made where it will contaminate water.

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

The LWO currently preferred pesticide is malathion for effectiveness and safety. Dieldrin will only be used until existing stocks are exhausted. BHC is used with ground teams that do not have access to hand held ULV equipment. The use of BHC will be phased out when adequate supplies of ULV equipment becomes available.

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

It is often difficult to assess the efficacy of treatments during a locust campaign because it may take 24-48 hours to kill the locusts. By this time ground teams have moved on. A major limiting factor is the availability of vehicles. Leaving a person behind to monitor efficacy would decrease vehicles available to survey and control personnel. USAID would support efforts by LWO by assisting with technical expertise and training for monitoring the environment.

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

This can be accomplished in India by treating settled swarms. The LWO avoids treating swarms while they are in flight whenever possible. Hopper bands are treated as early as possible to prevent their growth and migration. The survey is designed to find and treat swarms before they oviposit.

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

In India, helicopters are used for surveillance and during treatments. Helicopters are preferred for treating areas that are small or when ferrying distance is short.

Recommendation 11. It is recommended that whenever possible small planes should be favored over medium to large two or 4 engine transport types. In all cases experienced contractors will be used.

At one time, India had experienced agricultural pilots available within the Ministry of Agriculture. Now pilots are

available from the military or privately contracted. Only a few airplanes or helicopters are available for spraying pesticides. If more are needed FAO could contract for pilots or aircraft internationally with USAID grant funds provided they were used only to apply USAID approved pesticides. The Indian pilots are most familiar with treating croplands. Techniques are different when using ULV formulations for locust. Indian aircraft need to be fitted with ULV type applicators and training provided in their use.

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

The LWO would welcome any technical assistance that would come as part of a package of assistance. With new equipment comes the need for learning how to use it safely. Technical assistance would be useful for modernization of LWO including, survey, new application technologies, and environmental assessment and protection.

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

Pesticides used in India are labeled in English as per the Insecticides Act.

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

The Insecticides Act requires that all empty pesticide containers be "broken and buried" away from habitation. The LWO is currently storing empty pesticide containers until final disposal can be completed in a safe effective manner. USAID requires that any empty pesticide containers purchased with USAID granted funds be destroyed in a manner that they cannot be reused. The LWO is currently using existing stocks of dieldrin only until the supply is exhausted. Alternatives to this would be considered if they could be identified.

Recommendation 15. USAID should support the design, reproduction and presentation of public education materials on pesticide safety (e.g., TV, radio, posters, booklets). This would include such subjects as safely using cost

effective pesticides, ecology, pest management of locust and grasshoppers, and the hazards of pesticides. The goal would be to help policy makers and local populations recognize potential health problems related to pesticides applications.

The LWO Staff arranges on the spot training to village level officials, farmers and the general public on pesticide safety, particularly during the period of the anti locust campaign. They are told about pesticide hazards and various precautions to be taken to safeguard the health of operators and to minimize the insecticide exposure to the general environment including human settlements and grazing animals. As new pesticides and application methods are introduced to India, LWO staff will need training in their use so that this information can be provided to the public.

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

The Ministry of Agriculture recognizes the importance of educating the public and its own personnel on the proper and safe use of pesticides. During the 1993 operations a physician with his team was on site to monitor the health of personnel involved in application of pesticides. Apart from this, training was imparted to the locally posted doctors on recognition and management of pesticide intoxication. There is a need to conduct more training programmes for the primary health center doctors, health workers and paramedical workers in this aspect for regular monitoring the health of persons involved in application of pesticides. Emergency transportation (an ambulance) and medical equipment is needed to be available during locust control operations.

Recommendation 17. It is recommended that each health center and dispensary located in an area where pesticide poisonings are expected to occur should be supplied with large wall posters in which the diagnosis and treatment of specific poisonings are depicted. The centers and dispensaries should also be provided, prior to spraying with those medications and antidotes required for treatment of poisoning cases.

The Ministry of Agriculture distributed 2 booklets, namely "Know Your Pesticides" and "Management of Pesticide Poisoning" to each health center and dispensary located where pesticide poisonings are expected to occur. The Centers and Dispensaries

were also provided with specific antidotes and supporting medicines required for treatment of pesticide poisoning cases. In the future, different posters in this aspect along with small booklets already provided need to be updated for new pesticides and distributed to all health centers for helping doctors and health workers in diagnosis and management of pesticide intoxication. A supply of sufficient quantity of antidotes and supporting medication need to be maintained or provided as needed.

Recommendation 18. It is recommended that presently available tests for monitoring human exposure to pesticides should be evaluated in the field. This includes measurements of cholinesterase levels in small samples of blood as a screening test.

The LWO would welcome technical assistance, equipment and training for monitoring personnel cholinesterase levels.

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

All purchases of pesticides under grants from USAID of FAO will follow their regulations for contracting. Specifications for quality and packaging can be defined in the bid tenders.

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

Containers need to be sufficiently durable for transportation and storage under tropical conditions. Also the size should be appropriate for the end user. Malathion in India is available only in 200 liter drums for use in ULV application.

Recommendation 21. It is recommended that *Nosema* and other biological agents such as neem be field tested under African and Asian conditions in priority countries.

Since 1987, USAID/W, has invested nearly $2.3 million in developing biological control of locusts.

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

At present the USAID Mission in India has very little involvement in technical assistance in agriculture and no personnel with expertise in pesticides or locust control. USAID intends to use the expertise of the FAO for effective direction and dispersion of funds.

Recommendation 23. It is recommended that local programmes of training be instituted for pesticide storage management, environmental monitoring and public health.

International technical training is recommended for locust surveying and forecasting, training of trainers for ground application with ULV equipment, setup and use of aerial ULV equipment, monitoring of health effects i.e. cholinesterase levels, and environmental impact monitoring.

Recommendation 24. It is recommended that when technical assistance teams are provided, they be given short term intensive technical training pertaining to the host country and some background in the use and availability of training aids.

This SEA supports this recommendation.

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

A constant problem in trying to evaluate locust and grasshopper control in economic terms is the lack of data. If the benefits of control measures are to be evaluated there is a need for this data applicable to India.

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

India currently uses locust gregarization as an indication that the economic threshold has been reached. Solitary phase locust are not normally treated. It is considered too risky to allow gregarious phase locust to disperse. Research in India could better define the economic threshold for intervention. USAID has contracted with Oregon State University for work done in this area. The LWO wishes to be supplied with the results of these studies when completed. Any economic consideration must deal with economics of plague prevention, and not solely the economics of treating a particular swarm. Economic evaluations must consider the situation internationally as well as locally.

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

Legislation exists in India for the registration of insecticides and for the protection of the environment. At present only malathion, fenithrothion and BHC are registered for use against desert locust. Dieldrin is approved only until existing stocks are depleted. USAID or FAO could assist in providing data for the registration of other pesticides that have proven effective and safe in other countries.

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

Data on pesticide registration, production and use is recorded in India. As long as desert locust control in India remains in the desert regions there is little potential for cumulative effects of multiple pesticide treatments for different programmes. If desert locust escape from the desert regions these effects should be considered.

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

This handbook has been completed and a copy supplied to the LWO in India.

Recommendation 30. It is recommended that technical assistance, education, training, and equipment be provided to crop protection services of host countries to make the services self sustaining.

The LWO of India independently functions well for the control of desert locust. India cooperates internationally as a member of ECLO. Additional international assistance is only requested during major locust outbreaks, when international cooperation is necessary for success. ULV technology and newer pesticides would facilitate elimination of the use of the persistent pesticides, dieldrin and BHC.

Recommendation 31. It is recommended that more pesticide storage facilities be built. Until then, emergency supplies should be prepositioned in the United States.

India has adequate pesticide storage facilities in the region where locust control is likely. Development of alternatives such as the purchase of pesticides on an on-need basis need to evaluated. Malathion is produced and available in India. It should be determined if India-produced malathion meets international standards for use and could be contracted for under FAO or USAID guidelines.

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

The international assistance of forecasting and remote sensing would be important to India. India has remote sensing capabilities for monsoon/drought prediction as it relates to crop production. Technical assistance for adapting this capability for locust forecasting and survey targeting would be beneficial. Improved forecasting would allow for better resource targeting and preparedness here for potential invasions of swarms.

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

In India the greatest need for health monitoring is with the LWO personnel involved in application. Resident populations are unlikely to be exposed to application of pesticides for desert locust control. Field cholinesterase test kits need to be evaluated in India. Technical assistance is needed in their use.

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

Entomologists at the Indian Agricultural Research Institute are studying the use of insect growth regulators against locust.

Recommendation 35. It is recommended that applied research be carried out on the use of neem as an antifeedant.

Neem has had a long history of use in India, primarily against household and storage pest. Neem cake was applied to rice and sugarcane fields as early as 1930 to prevent infestations of stemborers and termites. Some innovative farmers even today 'puddle' green twigs and leaves of neem in rice nursery beds to ward off attack of early pests like leafhoppers, planthoppers and whorl maggot.

India was first to demonstrate experimentally the antifeedant properties of neem against locusts. The research carried out in India has demonstrated that certain neem derivatives are insecticides, fungicides, nematicides, antifeedants, repellents, metamorphosis disrupters, ovicides, etc. against various pests. Neem research in India reveals that neem acts as an antifeedant, oviposition deterrent and growth retardant against locusts. Support is needed to further investigate the properties of neem derivatives and how neem extracts could be used in an IPM programme against locusts or grasshoppers.

Recommendation 36. It is recommended that research be carried out to determine the best techniques for assessing insecticides for locust and grasshopper control.

The LWO has at Bikaner, the Field Station for Investigation on Locust. Here, insecticides could be tested for efficacy against desert locust or other arid zone grasshoppers. Studies could be conducted on insecticides that are not yet registered in India, but that are approved by USAID or FAO.

Recommendation 37. It is recommended that USAID provide guidance in locust/grasshopper control to missions in the field.

USAID provides such guidance.

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

USAID will channel granted funds for locust control in India through the FAO.

SUMMARY OF OPERATIONAL PROCEDURES, INDIA

The LWO will follow the procedures outlined below when conducting locust control programs in India:

1. Follow all National, State, and local laws and regulations and follow label instructions for application of pesticides.

2. Consult with Ministry of Environment and Forest for protection of species listed in Schedule I, II, III, and IV of the Wildlife (Protection) Act.

3. Instruct all program personnel on the use of equipment, materials and procedures; supervise to ensure procedures are followed properly.

4. Maintain quality control of aircraft and pilots. Aircraft and pilots that do not meet contract requirements will not be allowed to operate.

5. Notify residents in any treatment area, advising them of control methods and precautions to be taken.

6. Use flags or other markers to guide pilots during application of pesticides.

7. Provide two way radios for all field personnel.

8. Provide safety kits, thermometers, flagging material and other equipment and make them available to relevant personnel with
training in their use.

9. Protect human habitations from spray operations. No aerial treatments will occur over congested areas of human habitation. Locust swarms will be harassed to leave congested area to where they can be treated safely.

10. Dispose of drums in accordance with The Insecticide Act. This Act requires that all empty pesticide containers be "broken and buried away from habitation." Empty drums will be stored safely until proper disposal can be completed

11. Conduct mixing, loading and unloading in an area where accidental spills will not contaminate a water source.

12. Develop guidelines to set forth procedures to follow in the event of an accidental spill.

13. Conduct pilot briefing to ensure their familiarity with the area to be treated.

14. Notify local emergency personnel of pesticide storage areas and areas to be treated.

15. Supply protective clothing to all pilots, loaders, and field personnel involved in pesticide handling and application.

16. Apply pesticides in a manner that will not contaminate water (lakes, ponds, wells, etc).

17. Apply pesticides only on crops for which the particular pesticide is approved.

18. Monitor weather conditions at treatments areas before and during applications. Application will be stopped anytime it appears that weather conditions would jeopardize safe placement of the spray to the target areas.

19. Assure that all personnel involved with pesticide application have base line cholinesterase tests before the first applications and when deemed appropriate during the control efforts.

20. Match the applied pesticide with proper equipment for safe effective application.

21. Replace Dieldrin and BHC with less toxic pesticides.

22. Consult Parks and Sanctuary managers for protection of sensitive species before treatments in their areas.

23. Provide local representatives and interest groups with an opportunity to observe segments of the control operations.

24. Emphasize treatment of settled swarms and hopper bands in remote areas to prevent invasion of cropping region and plague prevention.

25. Cooperate with international locust control organizations for exchange of information, increasing forecasting ability and preparedness.

26. Conduct further research in safe, effective management of locusts and grasshoppers.

MODERNIZATION AND DEVELOPMENT NEEDS

The international locust control organizations have made a major shift in locust control strategies and technologies used in the last ten years. This shift has evolved around elimination of the use of dieldrin, BHC and other chlorinated-hydrocarbons, and the introduction of ULV application technologies. Many of the north African countries started this transition during the locust

and grasshopper outbreaks of 1986-1990 with the support of USAID and FAO. India has been slow to make this transition because GOI has not been involved in large scale locust control for a number of years.

At the beginning of the locust upsurge in July 1993, the LWO had supplies of dieldrin and BHC, and ENS and power duster for their application. Application aircraft had long ago been transferred to other departments in the GOI. Vehicles were aging and falling in disrepair. During the 1993 locust campaign, aircraft had to be hired, many vehicles and radio equipment were borrowed. The Ministry of Agriculture made a request through the FAO for emergency assistance and cooperation for the modernization of the LWO operations in India. The US government responded by granting FAO $750,000 for locust operations in Asia (India, Pakistan and Afghanistan). A PEAP (Appendix B) was prepared for USAID to define immediate assistance needed and measures to be taken to protect the environment and human health. Much of the assistance is designed to meet emergency needs and to enable the LWO to replace the use of dieldrin and BHC with less persistent pesticides.

Supplying the LWO with rotary ULV application equipment will enable the LWO to utilize malathion and fenithrothion effectively and safely. There is a need to retrofit aircraft with ULV application equipment. This is most effectively done with rotary ULV applicators but can be accomplished with a boom and nozzle configuration if properly designed. It is likely that the LWO will continue to hire aircraft when needed. Available aircraft in India are not equipped with rotary ULV applicators. There is the need for the LWO to have the equipment on hand and the ability to equip hired aircraft on arrival with rotary ULV equipment.

Most of the ground application vehicles utilized by the LWO are equipped with ENS or power dusters for application of dieldrin or BHC. Fitting these vehicles with ULV applicators would enable the LWO to effectively utilize malathion or fenithrothion. Village brigades have in the past been equipped with hand dusters for BHC. Equipping the village brigades with hand-held ULV (MicroULVA) applicators would enable them to use malathion or fenithrothion. None of this equipment should be supplied without appropriate training.

Communication equipment is needed for base stations, vehicles, and aircraft. Radio equipment is needed for effective operations as well as for the safety of personnel in the field. Communication between ground and aircraft is necessary for target identification, making sure the insecticides are applied in the correct location and that the insecticides are not applied to sensitive areas or human habitations. GPS units will assist with navigation, target location and accurate record keeping.

More protective clothing is needed for staff and village brigades. This equipment is intended for workers at risk due to high and/or long-term exposures, i.e., formulators, aircraft loading and service crews, mist blower operators, etc., and would include industrial grade head and eye protection; organic vapor respirators; and chemical resistant coveralls, boots, and gloves. There is also a very large need to replenish supplies of protective clothing that were used up during this past season's campaign. These supplies are sure to be needed in the future. Protective clothing and training will be provided to all appropriate applicators of USAID approved pesticides, including village worker/brigades.

Technical assistance is needed to develop criteria and methods for monitoring the environment and human health. Much of the area being treated in Rajasthan is very remote desert and since it may take up to 48 hours for insecticides such as malathion, carbaryl, and fenitrothion to result in significant locust mortality, control workers normally have moved on to other areas before results of treatment are observable. Assessments of efficacy are approximations only, and are not based on quantitative sampling techniques.

The health of applicators is monitored by a staff physician Trained in recognition and treatment of pesticide intoxication. Testing of cholinesterase levels in applicators is needed.

A major concern of the LWO is the lack of vehicles and the deterioration of vehicles available. The LWO is looking for ways to replace its aging vehicle fleet. If ULVAMast applicators are supplied there may not be enough vehicles to mount them on. Dependable vehicles are necessary for all aspects of locust control. The safety of staff while surveying or treating in remote desert locations depends on their vehicle and the communication equipment in that vehicle.

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Appendix A

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Appendix B

21 October 1993

PESTICIDE ENVIRONMENTAL ACTION PLAN

REPUBLIC OF INDIA

Current Action Plan:

The first swarms of desert locust arrived in India 6 July 1993. By early August smaller swarms were arriving daily on the winds from the west. Mature locusts deposited eggs in many locations during August. On 28 August the first major swarm arrived. Locusts had invaded an area from Bhuj to north of Bikaner in the states of Rajasthan and Gujarat. Ten swarms are known to have entered the region on 14 September. All but a few swarms have stayed in the Rajasthan Desert. Those swarms that left the desert to the east were quickly controlled by the GOI. One swarm entered Madhya Pradesh but returned to the desert on changing wind currents the 17 September. The number of swarms in the Rajasthan began to decrease in late September, but hopper bands continue to hatch in some areas. It is likely that a few swarms will exist through the end of October. Hopper bands may continue into early November.

The largest number of swarms entered India in late August and early September. The GOI has mobilized 650 personnel for the desert locust campaign. Two application airplanes and 4 helicopter were loaned to the crop protection service. One helicopter has crashed during the campaign. The crop protection service does not have any aircraft of its own.

The GOI takes pride in having kept all locusts out of any cropping areas. This was their first objective. Secondly, swarms of locusts have been treated as they are found and followed. Swarms are treated by aircraft and/or vehicle mounted exhaust nozzle applicators. Hoppers band are treated with ground and vehicle mounted application equipment. "Village brigades" are mobilized for treating hopper bands with BHC dust. One technique used by village brigades is to line trenches with BHC dust and drive the hoppers into the trench. At this time the GOI is trying to treat all swarms to prevent their return to Pakistan and the Arabian Peninsula.

The GOI has several requested priorities for donor assistance. First they would like to improve their remote sensing capabilities and field navigation equipment (GPS). Second, they lack sufficient ground to air and ground to ground communication equipment. Their vehicles are getting old and in disrepair. The upgrading of vehicles to four wheel drive is a longer term goal.

Forth, they are interested in receiving more practical field technical training of the type now being provided by FAO (H. Dobson), including new strategies of locust control, vehicle mounted ULV equipment use, application techniques, and calibration techniques. A long term goal is to replace the chemical pesticides with biological control and LWO is interested in pursuing research in this direction.

Environmental Considerations:

(1) Procurement and use of only USAID approved pesticides.

All pesticides to be procured under the USAID grant to FAO will be purchased by FAO Headquarters in Rome using standard FAO procurement procedures. All pesticides must conform with FAO specification as to quality of the product (active ingredient, formulation, physical and chemical characteristics and freedom from contaminants), size and characteristics of the container and labeling. FAO requires analysis of all substantial(>10,000 liter) purchases of pesticides to insure quality. All bids are tendered internationally. Local suppliers are included if they respond to the bid invitations and are capable of complying with all specifications. For emergency provisions, specifications include air freight to the required location. Other selection criteria include availability, unit applications costs, delivery time and site requirements. FAO historically purchases pesticides in lots of 30,000 liter, corresponding to typical campaign needs and maximum capacity of most chartered delivery aircraft. FAO would like to create a pesticide bank, a concept in which open ended contracts are established with key suppliers and stocks are not shipped until conditions warrant. This is particularly important in India which has already received stocks of pesticides sufficient for this year.

For the locust campaign in India, USAID funds will only be used for the purchase of USAID-approved pesticides that are also approved by FAO and are registered by India's Ministry of Agriculture for desert locust control (Table 1). The only chemicals meeting all these requirements are Malathion and Fenithrothion. It should be noted that although field trials of microbial pesticides are being supported by several donors, including USAID, that no microbial formulations are presently approved for desert locust control by the USEPA, FAO or the Ministry of Agriculture in India. GOI utilizes two pesticides in some of its locust control campaigns which are banned in the US: Dieldrin and BHC (Benzine hexachloride). India's Ministry of Agriculture is cognizant of the potential dangers of dieldrin and has banned its use in all applications except desert locust control in remote locations. Its continued use for desert locust control is justified by GOI officials by its efficacy, restrictions of use to remote locations and its decision to use up dieldrin stocks in this manner. GOI has banned the

manufacture and importation of dieldrin. Residual stocks are estimated to be 50,000 liters. BHC is not banned in India, but its use is restricted to non-crop situations. A 10% dust formulation is registered for desert locust control. BHC is applied with vehicle-mounted power dusters (by Ministerial staff) or with manual dusters (by trained villagers).

Both the FAO and India's Ministry of Agriculture were informed of the USAID's prohibitions on commingling any resources provided by the grant with any application of dieldrin and BHC. Both parties concur to enforce this prohibition. The Indian Ministry of Agriculture explained that such a separation of resources is feasible since each locust control district is relatively autonomous, reporting back directly back to the campaign coordinator. FAO Headquarters relayed their intentions to place an FAO Consultant in India for the duration of the campaign to assure that USAID resources were not commingled with operations involving dieldrin or BHC.

USAID consultants Castleton and McNary also discussed the question with Dr. Ragunathan (National Director of Locust Control and Plant Protection Advisor to the GOI). They are convinced that the GOI seeks to move towards the exclusive use of more environmentally safe pesticides in the immediate future and that the locust control units have the level of organization and training necessary to prevent the commingling of non-approved pesticides with resources provided under this grant.

Table 1. Governmental Approval for Pesticides used Against Desert Locust in India.

PESTICIDE	USAID APPROVED	FAO APPROVED	GOI APPROVED
Malathion	Yes	Yes	Yes
Fenitrothion	Yes	Yes	Yes
Beniocarb	Yes	Yes	No
Chlorpyrifos	Yes	Yes	No
Diazinon	Yes	Yes	No
Lamba-Cyhalothrin	Yes	Yes	No
Acephate	Yes	No	No
Carbaryl	Yes	No	No
Tralomethrin	Yes	No	No
BHC (10% Dust)*	No	No	Yes*
Dieldrin**	No	No	Yes**

*Restricted use pesticide
**Outlawed in India, except to use existing supplies to control desert locust in isolated areas.

PROPOSED ACTION

The FAO proposes to use the USAID granted fund in India to purchase the items in Table 2. No pesticides will be purchased at this time because of the general decrease of the number of swarms and the adequate supplies of USAID approved pesticides in country. These purchases are designed to modernized the control techniques being used. Such modernization induces a move away from using Exhaust Nozzle Sprayers with Dieldrin and BHC dust to using ULV techniques with Malathion and Fenithrothion. Consultants to train in ULV techniques and safety are included to further this transfer toward safer and newer technologies.

Table 2. Proposed purchases under USAID grant to FAO in India

Number Requested	Material Requested	Unit cost	Total FAO/AID funds
16	ULVAMAST for vehicles	$6000	$ 96,000
400	MicroULVA	$ 25	$ 10,000
75	VHF Handheld Radios	$ 500	$ 37,500
30	HF Vehicle Radios	$3500	$105,000
10	HF Base Radios	$3500	$ 35,000
600	Protective clothing: Nitrile Rubber Gloves, coveralls, goggles, boots		$ 20,000
5000	Disposable dust Mask	$ 1	$ 5,000
30	Crew Kit: Anemometer, pocket compass, plastic measuring cylinder, tool kit, mechanical tachometer (Vibratak)	$ 100	$ 3,000
	Equipment to modify aircraft for ULV		?
4 weeks Consult	Training of Trainers for MicroULVA and pesticide safety for field crews and village brigades.		$ 12,000
4 weeks Consult	ULV Application for pilots		$ 12,000
4 weeks Consult	Evaluate feasibility of Cholinesterase testing and training of medical personnel, Plus field kits		$ 20,000
20	Portable GPS devise	$2000	$ 40,000
		TOTAL	$395,500

(2) The safe distribution, storage, use and disposal of pesticide containers.

PROPOSED ACTIONS

India's locust control personnel anticipate the need for both aerial and ground control operations, using ULV formulations of malathion and fenitrothion **if swarms of desert locust invade in June 1994.** The initial strategy will be to spot all incoming swarms and spray them while the swarms are roosting or on the ground feeding. No air to air treatments are anticipated. Spray planes are to be used along the border with Pakistan in the area where shifting sand prevents use of ground application equipment. Desert locust control teams with vehicle mounted ULV equipment (mainly Micron ULVAMAST) will control settled swarms in accessible areas. The objective being to control locusts before pink swarms mature, turn yellow, and deposit their eggs. If the desert locust unit is overwhelmed by the number of swarms and the locust lay eggs, the egg beds will be delimited and monitored for hatch. These hopper band will be treated by the locust control units or by village brigades. Only when large isolated tracts of desert harbor hopper bands will aircraft be used to locate bands and treat them. This strategy conforms with the guidelines published by FAO (Desert Locust Guidelines, Vol.IV Control, Vol. V Campaign Organization and Execution).

The pesticides to be used are ULV malathion and fenitrothion, the only products mutually acceptable to USAID, FAO and GOI. They are registered for use in India as restricted use pesticides due to their high concentration of active ingredient and will be solely used by trained personnel from the desert locust control units, contract aerial applicators or supervised village brigades. **In preparation for the June 1994 campaign a modest quantity of pesticide will be prepositioned in Rajasthan.** The strategy being to replenish these stocks only as needed from FAO procured sources. This will minimize the need for storage facilities and the potential risk of creating an excess of pesticide if a plague does not develop. The Director of locust control affirms that the label on the pesticide to be purchased by FAO with USAID funding should be in English since its use will be restricted to trained staff.

Copies of the USAID Locust/Grasshopper Operations Guidebook and the Pesticide Applicator's Handbook will be used to supplement the FAO's guidelines regarding protective equipment and proper pesticide storage. In general, the policy of India's locust control units is to provide all field personnel involved in pesticide transfer or mixing with a complete set of protective gear, including a face shield, gloves, overalls and gumboots. Drivers of the vehicles carrying application equipment will also be provided with respirators with organic vapor filters. Some

protective gear is distributed to the village brigades but most villagers may only have access to improvised protective clothing (Clean turban and change of clothes). Protective clothing and training will be provided to all applicators of USAID-approved pesticides, including village worker/brigades.

All transfer of pesticides from the 200 liter drums will be done by trained locust control officers equipped with a full set of protective gear. For aerial operations a metered pump is desirable, for ground control operations manual pumps specially designed for pesticides is sufficient. Pesticides will be stored only in their original containers. Presently empty pesticide containers are stored in government warehouses under lock and key, awaiting a decision by the Ministerial Advisory Committee as to the proper empty container disposal technique. FAO has also suspended distribution of its 1985 guidelines for on the farm disposal of excess pesticide and containers until its expert committee can revise it. The USAID operations manual calls for triple rinsing of drums, but this may not be feasible in the Rajasthan deserts. A drum crusher would however prevent reuse of drums by villagers, minimize the storage volume, and avoid littering the desert landscape. This suggestion will be made to the Ministry for possible inclusion in their policy.

Adherence to USAID's policy of puncturing drums during the current campaign will be monitored by a FAO consultant.

The GOI intends to return any pesticides not used that were purchased under the FAO to FAO's control.

(3) Contractor quality control.

The local FAO Rep has the authority to hire an aircraft locally for excursions but cannot hire aircraft for application of pesticides or survey of locust populations. Contracting for aerial application aircraft (airplanes/helicopters) and aircraft for locust survey is handled at the FAO in Rome. Bids are requested internationally. Specifications are defined in Rome according to the needs and requirements of the host country. Contracts will define the experience required of the pilots, the regions where pesticides are to be used, time frame of probable activity and what pesticides may be applied with a particular aircraft. (See question 1 for list of approved pesticides for India.) Contracts are let according to the "FAO Manual."

PROPOSED ACTIONS

No outside pilots will be contracted during the current campaign. Quality of current application pilots will be improved by supplying a consultant for training in ULV application techniques, target identification will improve with the use of supplied GPS devises and radios for aircraft and ground crews.

Training will also emphasize conversion to ULV equipment, aircraft calibration, and safety.

(4) Training of sprayers in spraying techniques, health and safety requirements.

The government of India has historically had a strong control program against desert locust. Many well trained persons work with the GOI on locust control. This is the first year in many that outside assistance has been requested. During this year's campaign there were experienced agricultural pilots available from the Indian Aviation Wing. One Indian trainer had been in England for one year of training on setting up and using ULV equipment and has been training his coworkers. An FAO Consultant (H. Dobson) has been conducting application training during this campaign.

PROPOSED ACTIONS

During phase down (currently underway) of this campaign, training will be presented by FAO consultants to pilots on ULV application techniques including: equipment, calibration, target identification, and safety. Sessions will be organized for a Training of Trainers in MicroULVA use and safety, and use of protective clothing. This information can then be presented to village brigades before their participation in control activities. A Consultant will be hired to evaluate Cholinesterase Testing Kits and to supply training in their use to field medical personnel.

(5) Notification of affected communities vis-a-vis spraying plans and precautions.

PROPOSED ACTIONS

General information about upcoming spray programs and the precaution necessary will continue to go out over the radio. Exact locations of spray boundaries will be marked by flags or burning tires whenever possible. State police will be notified when treatment activities are likely. Communities have often assisted in the control efforts themselves. This gives many local villagers personal knowledge of program activities. Villagers are most active in reporting swarms, harassing adult locusts out of villages, destroying locust eggs, and dusting hopper bands. Two way radios purchased under this grant will be used for keeping base stations informed of active treatments. This information with be passed on to local authorities.

(6) Avoidance of spraying human settlements, ecologically sensitive areas, protected areas and the habitats of important species (especially wetlands and endangered species).

Protected areas.

Four of India's National Parks are in the state of Rajasthan. The Ministry of Agriculture claims not to have treated within any of these parks during the current campaign. Desert National Park is the only National Park where locusts are likely to have occurred. Other parks are outside the desert region where locust are likely to occur.

Table 2. National Parks In Rajasthan.

1.	Keoladeo Ghana	Bharatpur District	28.73ha
2.	Ranthambore Tiger Res.	Sawai Manhopur District	392.00
3.	Sariska Tiger Res.	Alwar District	273.80
4.	Desert National Park	Jaisalmer	3162.00

Table 3. Wildlife Sanctuaries in Rajasthan.

1.	Banda Baratha	Bharatpur District	92.76ha
2.	Bassi	Chittorgarh	152.00
3.	Bhensroadgarh	Chittorgarh	229.14
4.	Darrah	Kota	265.03
5.	Desert	Jaisalmer	3162.00
6.	Jaisanand	Udaipur	52.00
7.	Jamwa Ramgarh	Jaipur	300.00
8.	Jawahar Sagar	Kota	100.00
9.	Keladevi	Sawai Hadhopur	676.38
10.	Kumbhalgarh	Udaipur	678.25
11.	Mt. Abu	Sirohi	288.84
12.	Nahargarh	Jaipur	50.00
13.	National Chambal	Kota	280.00
14.	Phulwati	Udaipur & Pali	511.41
15.	Ramgarh Visdhari	Bundi	307.00
16.	Sariska	Alwar	492.00
17.	Sajjangarh	Udaipur	5.19
18.	Shergarh	Kota	98.71
19.	Sita Mata	Chittorgarh	422.94
20.	Sawai Mansingh	Sawai Madhopur	103.25
21.	Sunda Mata	Sawai Madhopur	107.00
22.	Tal Chapper	Churu	7.90
23.	Todgarh Rawali	Ajmer	405.27
24.	Van Vihar	Dholpur	59.93

Endangered species.

The Indian Wildlife (Protection) Act, 1972 affords protection to the endangered species of India. Several species of concern live in the desert areas of north west India. These are:

The Desert Wolf
The Indian Desert Fox

The Indian Desert Cat
The Great Indian Bustard
The Indian Desert Monitor

Poaching and lost of habitat are the greatest threat to these animals. Each of these animals is at least partially insectivorous and could feed on contaminated locusts. Of these the Great Indian Bustard may be the most susceptible to pesticides, especially fenitrothion, for desert locust control. These animals and others would act as bioaccumulators of dieldrin and BHC, emphasizing the urgency to replace the older chemicals with modern chemicals and techniques

Other animal species of concern exist in this region. The Wild Ass of Rann of Kutch in Gujarat is protected at the Wild Ass Sanctuary. Tigers and lions in this region, live only in a few wildlife sanctuaries in Rajasthan and Gujarat. Their present locations are unlikely to conflict with desert locust control. The Chimkara (gazelle) and the Blackbuck are protected in Rajasthan

Plant species listed as of concern in the states of Rajasthan and Gujarat by the Indian Institute of Ecology and Environment are:

Commiphora wightii	Burseraceae
Helichrysum cutchicum	Asteraceae
Hyphaene dichotoma	Arecaceae
Rosa involucrata	Rosaceae

The exact status of these species is unknown at this time. It is unlikely that locust control programs would contribute to their decline.

PROPOSED ACTIONS

If a locust swarm enters a village, pesticide application ceases; villagers will harass the locust to move to where pesticide application can begin. Still, people and herds may be exposed to pesticides. Pilots will be instructed to be as careful as possible and to turn off spray booms over individuals that accidentally are within a spray block. If applied properly, such minimum exposure of Malathion or Fenitrothion does not pose a health risk to humans or livestock. Training of pilots will concentrate on calibration ensuring that individuals accidentally in a spray block will not be overdosed.

No pesticides will be applied in National Parks. If proposed treatments pose a threat to sensitive species, mitigative action will be developed with authorities in the Ministry of the Environment.

Two way radios will ensure quick communications enhancing ability

to protect the environment. Locations of sensitive areas will be recorded with the GPS for exclusion from application.

(7) Monitoring of pesticide use, effectiveness, and safety

PROPOSED ACTIONS

Much of the area being treated in Rajasthan is very remote desert and since it may take up to 48 hours for insecticides such as malathion and fenitrothion to result in significant locust mortality, control workers normally have moved on to other areas before results of treatment are observable. Any assessments of efficacy which are made are approximations only, and are not based on quantitative sampling techniques. Sprayed areas will be returned to as soon as possible to evaluate efficacy of treatments and effects on non-target species.

Workers will be provided with protective clothing to reduce exposure to insecticides. Under this procurement the GOI will be provided with a supply of appropriate protective clothing and equipment for workers exposed to pesticides in the course of the locust control effort. This equipment is intended for workers at risk due to high and/or long-term exposures, i.e., formulators, aircraft loading and service crews, mist blower operators, etc., and would include industrial grade head and eye protection; organic vapor respirators; and chemical resistant coveralls, boots, and gloves. There is a very large need to replenish supplies of protective clothing that were used up during this past season's campaign. These supplies are sure to be needed in the future. Protective clothing and training will be provided to all appropriate applicators of USAID approved pesticides, including village worker/brigades.

During the campaign a Medical Toxicologist was on site during the summer to train applicators in monitoring their health for signs and symptoms of pesticide toxicity. He also completed training sessions at the medical centers in western Rajasthan in recognition and care of persons with pesticide poisonings. They are not testing cholinesterase levels in their workers at this time. But a consultant will be provided to determine the feasibility of using field Cholinesterase Test Kits. Kits and training will be supplied under this grant.

APPENDIX C:

Figures 1 through 11.

Figure 1. Incursion of Locust Swarms from West, July-August 1993.

Figure 2. Incursion of Locust Swarms from West, Sept-Oct 1993.

Figure 3. Locust Situation, 07-9-93.

Figure 4. Locust Situation, 09-09-93.

Figure 5. Locust Situation, 01-10-93.

Figure 6. Locust Situation, 04-10-93.

Figure 7. Locust Warning Organization.

Figure 8. Regions Covered by SEA.

Figure 9. Sensitive Areas in Punjab and Haryana.

Figure 10. Sensitive Areas in Rajasthan.

Figure 11. Sensitive Areas in Gujarat.