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SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT FOR LOCUST AND GRASSHOPPER CONTROL IN THE GAMBIA

United States Agency for International Development

Mission to The Gambia

In Cooperation with the Government of The Gambia

Banjul, The Gambia

November, 1993

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	Assistant Administrator to USAID/AFR
AChE	Acetyl cholinesterase
AELGA	African Emergency Locust/Grasshopper Assistance Project - AID/Washington
AFR	Africa Bureau of USAID
AFR/ARTS/FARA	Office of Analysis, Research, and Technical Support, Division of Food, Agriculture, and Resource Analysis, Africa Bureau, USAID
AGRHYMET	Agro-Hydro-Meteorologie, based in Niger
APHIS	Animal and Plant Health Inspection Service of USDA
APMU	Agricultural Pest Management Unit, Gambian MOA
BHC	Benzene Hexachloride
CFR	US Code of Federal Regulations
CIDA	Canadian International Development Agency
DDVP	Dimethyl Dichorovinyl Phosphate, an OP pesticide
DLCO-EA	Desert Locust Control Organization for Eastern Africa
DRCO	Disaster Response and Coordination Office of USAID/AFR
EA	Environmental Assessment
ECLO	Emergency Center for Locust Operations, FAO
EEC	European Economic Commission
EPA	US Environmental Protection Agency
	The Gambian Wildlife Conservation Organization
FAO	Food and Agriculture Organization of the UN
FAO/WFP	World Food Program, FAO
FMI	Force Maghrebian d'Intervention, for North Africa
GOTG	Government of The Gambia
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit, German Development Agency
ha	hectare
IAR	The Gambian Institute for Agricultural Research
IFAD	International Fund for Agricultural Development
IIBC	International Institute for Biological Control, England
IITA	International Institute for Tropical Agriculture, Biological Control Unit in Cotonou, Benin
IPM	Integrated pest management
ITCZ	Intertropical Convergence Zone, a weather system
km	kilometer
mg/kg	milligrams per kilogram
mm	millimeters
MOA	Ministry of Agriculture

NEA	Gambian National Environmental Agency, Office of the President
OCLALAV	Organisation Commune de Lutte Antiacridienne et de Lutte Antiaviaire, based in Dakar
ODA	Overseas Development Agency, United Kingdom
OP	Organophosphate insecticide
OSE	Senegalese Grasshopper
PEA	Programmatic Environmental Assessment
ppm	parts per million (ambient concentration)
SEA	Supplemental Environmental Assessment
SIDA	Swedish International Development Agency
TDY	Temporary Duty
ULV	Ultra Low Volume (pesticide formulation)
USAID	United States Agency for International Development
USAID/Gambia	USAID Mission to The Gambia
USAID/W	USAID at Washington, DC
USG	United States Government

PREFACE

This document is a supplement to the Programmatic Environmental Assessment (PEA) concerning United States Agency for International Development (USAID) assistance in locust and grasshopper control programs. This Supplementary Environmental Assessment (SEA) was prepared by a technical assistant to the AELGA (Africa Emergency Locust/Grasshopper Assistance) Project from USAID/W, with support from the Government of The Gambia (GOTG). Contact persons are listed in Appendix A.

This document will be reviewed by USAID/Gambia, the Government of The Gambia, and USAID/W. It reflects the best current description of future options for the USAID assistance programs to the Gambian Ministry of Agriculture (MOA) and the National Environmental Agency (NEA). It contains the best estimates of environmental impact and possible mitigating strategies. This may include training programs covering improved health and environmental protection, as well as support for early survey and spot treatment programs. Alternatives to chemical pesticides are encouraged in this document. This document also supports prudent and environmentally sound use of pesticides when these materials are necessary. Any commitments for possible future programs are contingent on the future needs for locust control, the capabilities of the GOTG, and on a decision by USAID to provide assistance.

1.0 EXECUTIVE SUMMARY

This assessment is a supplement to the Programmatic Environmental Assessment (PEA) for Locust and Grasshopper Control in Africa and Asia. It was developed to provide explicit, country-specific environmental details and guidance in The Gambia in order to allow USAID assistance for locust management. The material in this document considers the locusts species in The Gambia and the potential environmental impact of control operations. This environmental assessment is an extension of the PEA and is, as such, an integral part of it. The Gambia-specific PEA recommendations are included in Appendix B. An SEA was completed for Senegal in May 1991. There is some overlap in coverage between the Senegal and The Gambia, and commonalities in locust/grasshopper control. Both SEAs, this one and the Senegal SEA, along with the PEA, should be consulted during planning and operational stages of implementation.

The information contained in this document is intended for use by the USAID/The Gambia Mission and the Gambian Ministry of Agriculture (MOA) and the National Environmental Agency (NEA) to guide environmentally sound locust and grasshopper management in The Gambia. Additional relevant information should be added to this SEA as needed in the form of appendices.

INTEGRATED PEST MANAGEMENT

This document recommends that any U.S.-funded assistance concerning locust management should promote the development of integrated pest management (IPM) tactics for pest control. **An IPM program reduces pesticide usage by relying on a variety of locust control methods and using insecticides only when necessary. IPM also promotes monitoring, early warning, preventive measures,and threshold-based decision making when feasible.** Non-chemical methods of locust control can include destroying locust eggs by turning the soil and, in the future, applying micro-organisms (that are pathogenic to locusts, but not humans) to locust breeding areas. In addition, continued research into the identification and use of natural chemicals that are species or insect-group specific should be supported. The AELGA Project could collaborate with Agriculture Pest Management Unit (APMU) on egg pod destruction initiatives.

USAID supports survey and immediate treatment operations to prevent or proactively intervene against locust outbreaks.

Prevention reduces crop loss and operational costs. Early intervention requires less pesticide than later emergency operations, and therefore has less impact on the environment.

INVENTORY AND MAPPING PROCEDURES

This SEA recommends that dynamic inventory and mapping procedures be developed for determining and tracking environmentally fragile areas, pesticide stocks, manpower and equipment possessed by locust control groups; the Government of The Gambia (GOTG) should be responsible for officially mapping and designating environmentally fragile areas where pesticide use should be banned or limited. The GOTG should also maintain updated lists of the above needs. OCLALAV (Organisation Commune de Lutte Antiacridienne et de Lutte Antiaviaire) should provide the same types of information on inventories to FAO. FAO should then be responsible for establishing such a system of inventory for presentation to USAID/Gambia and other donors. USAID should take an active role, with OCLALAV and FAO in assisting in identifying alternate use or disposal of obsolete pesticide stocks.

ENVIRONMENTAL PROTECTION

Environmental awareness is emphasized in this SEA. The fragile ecosystems represented by rivers, lakes, and national parks merit special attention. Fragile ecological areas, as well as human settlements, need to be protected from chemical pesticides, as the impact can be both dramatic and long lasting. Buffer zones of 2.5 to 5 km surrounding established protected areas should be observed in any U.S.-funded locust control operation. Both chemicals that should and should not be used near these buffer zones can be determined from the usage characteristics of those listed in Appendix F. For instance, those that have a high toxicity to fish should not be used around aquatic habitats.

This SEA suggests that USAID should encourage The Gambia to monitor environmental pesticide residues. Monitoring for pesticide effects on non-target species and the environment should be included as an integral part of any pesticide use program. The results from this, as well as treatment efficacy, should be used in the planning and operational phases of future locust control programs to adjust or curtail environmentally damaging operations.

PESTICIDE MANAGEMENT

Proper pesticide management must be a priority in locust control operations. A list of the pesticides that can be provided by the U.S. is included in Appendix F. Directions on their management are provided in USAID's 1991 Pesticide Management Guidelines.

Misused pesticides have a negative effect on the environment, health, and crop production. When spraying is required, the minimum area should be sprayed, and small spray planes should be favored over medium to large two- or four-engine transport type planes. Pesticide storage, application, and disposal are important components of pesticide use. Expired pesticides are not yet separated from useable pesticides in The Gambia. USAID/Gambia should continue to monitor the storage situation, when possible.

Pesticides should only be stored with other pesticides and should **never** be stored with flammable or potentially explosive materials, or foodstuffs. Pesticide containers must be disposed of in a manner that will prevent food or water from being stored in them. This SEA encourages the Government of The Gambia to enforce its regulations dealing with pesticides. Pesticide disposal is problematic at this time due to a paucity of viable options. At the very least, the outdated and banned (in the USA) pesticides should be stored under proper conditions until disposal options become available. These issues must be fully considered and monitored in a USAID-funded activity.

As of November, 1993 the MOA had malathion 90% ULV stored at 4 sites in The Gambia: Sapu, Genoi, Bwian, and Yundum. Recommendations were made to the MOA and NEA that pesticide stores should be safeguarded against theft or intentional diversion for use on pests other than those intended, and should never be stored with food. The malathion stocks were sampled for viability by the author of this SEA. Other obsolete or banned (in the USA) pesticides should be stored properly and should continue to be stored until methods for their disposal are planned. The APMU and NEA have already produced an action plan for dealing with obsolete pesticides. Most are planned to be repackaged and shipped to Holland.

PUBLIC HEALTH

In the past, USAID, through the AELGA project has produced

an array of educational materials dealing with pesticide safety and health issues; USAID should now support the reproduction, distribution, and presentation of such public education materials in The Gambia. All health centers should be provided with posters describing diagnosis and treatment of pesticide poisonings, as well as medicines and antidotes required for treatment of poisoning cases. Analysis of blood acetylcholinesterase levels in handlers and applicators of organophosphate (OP) insecticides is recommended, and should be a part of any system using pesticides.

TRAINING

Training must be part of any USAID pest control assistance program. Attention to public health, pesticide safety, and the environmental effects of pesticide use and misuse should be emphasized to The Gambian Ministry of Agriculture and public health sector personnel, and to the general public through education and public awareness campaigns. Farmer training and village brigades can be an important and economical part of management operations, and their continued use should be stressed. Safe use of insecticides is encouraged and every shipment of pesticides from the U.S. is accompanied by safety equipment. A list of the safety equipment possessed by the MOA is included in Appendix H.

RESEARCH

Research on forecasting, monitoring, alternate control techniques should be pursued in The Gambia. Biological controls are being pursued in other parts of Africa by the AELGA project in coordination with Montana State University and Mycotech Corporation, and by the International Institute for Tropical Agriculture (IITA) in association with the International Institute for Biological Control (IIBC). Several promising fungal species have now been identified as possible controls for locusts and grasshoppers. One person from APMU has received training at the IIBC and is familiar with potential fungal biological controls. A commercial formulation of one fungal species strain may be ready for production and sale in late 1994. The use and efficacy of this fungal strain should be tested by APMU against grasshoppers and locusts. Greenness maps and rainfall data are of limited use in The Gambia due to the small size of the country and high percentage that is green due to the proximity to the Gambia River and its tributaries.

Research on locust control alternatives to pesticides has been carried out by the FAO in the past. This type of research should continue, and be transferred to The Gambia, and other countries in the Sahel. Such research includes the use of insect growth regulators and other chemicals which may disrupt locust behaviors, such as mating and swarming. More research is needed on the efficacy of various pesticides and pesticide application. The results of research on techniques for assessing environmental impact of insecticides, which has been performed in West African countries, should be transferred to and tested in The Gambia. As well, The Gambia has the potential to strongly support research on environmental impact, and results obtained there should be transferred to other West African countries. Just as important, results of the environmental assessments performed under the LOCUSTOX Project in Senegal should be transferred to the NEA and APMU for review for applicability to potential environmental impact in The Gambia.

IMPLEMENTATION

The AELGA Project has already provided technical assistance, situation reports, and guidance regionally and to USAID/Gambia on appropriate actions to take in dealing with locust and grasshopper outbreaks, and in completing this SEA and ones like it in surrounding countries. The AELGA Project, should continue to provide guidance in locust and grasshopper control to USAID/Gambia. USAID has worked multilaterally in the Sahel, and should continue to be involved in regional multidonor efforts to control outbreaks. Specific recommendations on actions to be taken by USAID/Gambia, APMU, FAO, and the NEA are provided in Appendix B.

2.0 PURPOSE AND PROCEDURES

2.1 Background

Due to a plague of locusts in eastern and sahelian Africa in 1987, the Administrator of USAID declared an emergency waiver of the Agency's Environmental Procedures [22 CFR part 216] governing the provision of pesticides. The waiver permitted USAID to procure and use pesticides for locust control without full compliance with the Agency's environmental procedures; at the same time it specified that a Programmatic Environmental Assessment (PEA) for Locust and Grasshopper Control in Africa and Asia be produced. The PEA was finalized in early 1989 and the waiver expired on 15 August 1989. Since then, all USAID assistance for procurement and use of pesticides must fully comply with the Agency's environmental procedures. The PEA and the country-specific Supplemental Environmental Assessments (SEAs) provide guidance on environmentally sound locust management procedures. SEAs have been completed and approved for most sahelian countries, Eritrea, Ethiopia, Kenya, Mozambique, Madagascar, Morocco, Somalia, Sudan, Tunisia, Yemen, India, Pakistan, and Afghanistan. In 1991, USAID's African Emergency Locust and Grasshopper Assistance (AELGA) Project reviewed the PEA and SEAs in a *Review of Environmental Concerns in A.I.D. Programs for Locust and Grasshopper Control*, Publication Series No. 91-7.

Locust and grasshopper control should involve preventive intervention, and, when necessary, emergency response. Ideally, strategic (preventive) locust management will preclude the need for emergency response. The spread of locusts into The Gambia requires rapid, coordinated measures to stop their movement further south. Such incursions could devastate large parts of The Gambia's agricultural production base.

The Gambian crop protection service, now called the APMU, will be the first line of defense against a locust invasion. This unit was formed in 1991 to provide technical expertise to various divisions within the Ministry of Agriculture. Regional locust and grasshopper control has been carried out in the past by OCLALAV. Unfortunately, OCLALAV has been severely limited in its capacity due to under-funding and is not operational. The long range goal of U.S. assistance should be to help effect a sustainable preventive approach to locust management in desert locust outbreak areas. This SEA will describe both the immediate

and long term measures necessary to achieve environmentally sound locust management in The Gambia.

Should USAID/Gambia choose to provide chemical pesticides, the Environmental Procedures in Regulation 16 (22 CFR 216) must be followed. The PEA and this document fulfill the requirements necessary to allow USAID to provide assistance to The Gambia.

2.2 Drafting Procedure

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

This SEA was completed in November, 1993 by entomologist and technical assistant to the AELGA Project, Dr. Alan C. Schroeder. The USAID/Gambia Mission and AFR/AA/DRCO's AELGA Project in USAID/W assisted in the preparation of this draft by providing logistical support for needed field work, reference documentation, and contacts within the Gambian government.

2.3. Previous Assessments

The previous assessment concerning this subject, and the primary supportive document is the Programmatic Environmental Assessment PEA for Locust and Grasshopper Control in Africa/Asia (TAMS/CICP, 1989). This SEA is a supplement to the PEA, and should be considered an integral part of the PEA. This document concerns the country-specific environmental issues not necessarily addressed in the PEA.

The following documents were used in preparing this assessment:

(1) Review of Environmental Concerns in A.I.D. Programs for Locust and Grasshopper Control (U.S. Agency for International Development, Washington, D.C., September 1991);

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

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

(4) Supplemental Environmental Assessments for Chad, Cameroon, Burkina Faso, Kenya, Mali, Mauritania, Niger, Senegal, Sudan, Madagascar, Mozambique, Eritrea, Ethiopia, Somalia, India, Pakistan, Afghanistan, Tunisia, Yemen, and Morocco.

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

(6) Pesticide User's Guide: A Handbook for African Extension Workers. (Overholt and Castleton, 1989, USAID/AFR/TR/ANR/AELGA, Washington, DC).

(7) Pest Management Guidelines of the Agency for International Development. (Overholt, Showler, Waite, and Larew, 1991, USAID, Washington, DC).

(8) Locust/Grasshopper Management: Operations Handbook. (USAID, 1989, Washington, DC).

(9) Assessment of the Africa Emergency Locust/ Grasshopper Assistance (AELGA) Project. (Schroeder, 1993).

(10) Proceedings of the USAID West African Regional Conference on Pesticide Disposal: Disposal of Pesticide Containers and Obsolete Pesticides. (USAID 1990, Niamey, Niger)

These documents and USAID/Gambia data were used in this SEA without citation. Other relevant documents are cited in section 5.0 and Appendix C.

2.4. U.S. Environmental Regulations

It is USAID policy to ensure that any negative environmental consequences of an USAID-financed activity be identified and mitigated to the fullest extent possible prior to a final funding

and implementation decision. This document covers specific environmental consequences involved with chemical pesticide use, and necessary safeguards and mitigation for any future control programs. In addition, alternatives to chemical pesticides are recommended when appropriate, and considered as being integrated pest management (IPM) tactics.

According to *Pest Management Guidelines of the Agency for International Development* (1991):

> "USAID's regulations require that the potential environmental consequences of USAID-financed activities are identified and considered by USAID and the host country prior to the final decision to proceed with an activity. The procedures that guide this regulation are set forth in 22 CFR Part 216. Section 117(c) of the Foreign Assistance Act and Section 533(g) of the 1991 Appropriation Act require that USAID review its projects, programs, and activities in accordance with requirements of 22 CFR Part 216. USAID's policy is to approve for procurement or use only those pesticides that are critically needed and proven safe."

U.S. pesticide contributions are regulated by U.S. pesticide laws and procedures (as described in the PEA). Only those pesticides listed in Appendix F can be procured using U.S. funds and can only be used in conjunction with other forms of U.S. assistance for locust/grasshopper control (e.g., aircraft). In a U.S.-funded operation, pesticides are to be used according to label instructions only. Used pesticide containers and any unwanted pesticide resulting from a U.S.-funded operation must be disposed of properly and safely. No U.S. funds shall be used to purchase, transport, or apply any pesticide that has been banned in the U.S. This includes the chlorinated hydrocarbons such as dieldrin, DDT, lindane, and benzene hexachloride (BHC).

2.5 The Gambian Environmental Procedures

2.5.1 Gambian Pesticide Regulations

In 1983, a Pesticides Control and Management Act was written to provide for "the control and management of the use of all pesticides imported or produced in The Gambia and for other matters related thereto." This act contains sections on pesticide registration, licensing of pesticide users, and

enforcement and penalties. Attached to this act are the following: a list of pesticides available and used in The Gambia in 1983 and quantities of each; companies/organizations importing pesticides into The Gambia, the year and products imported; application equipment for crop protection and vector control; locust/grasshopper control application equipment; and amounts of protective clothing and antidotes for pesticide poisoning of all pest management sectors.

The 1983 Act also has an attachment that lists DDT, eudrine, lindane, and bidrin as banned. Dieldrin is listed as restricted, in the same category with malathion 98% ULV and fenitrothion 91% ULV. Another attachment gives recommended pesticides and dosage rates for major crop pests, diseases, and weeds. Yet another attachment includes blood cholinesterase levels of people involved in control activities in 1987. Unfortunately, this act was never effectively implemented.

The 1983 Pesticides Control and Management Act was repealed in 1993, and a new act entitled "Hazardous Chemicals and Pesticides Control and Management Act" was written to be presented as a Bill before Parliament on December 15. The new act contains much more detailed sections and information on implementation. The responsibility for the administration and implementation of the act has been moved from the Agricultural Pest Management Unit of the Ministry of Agriculture to the National Environmental Protection Unit under the Office of the President. Government of The Gambia officials feel that this move will lead to more control over the pesticide situation. Further indications of the GOTG's resolve include the construction of an analytical chemistry laboratory equipped with a gas chromatogram for detailed chemical analysis. In addition, the GOTG intends to have a pesticide registration official in office by January 1, 1994.

The new act contains clauses which will have a direct bearing on locust and grasshopper control in The Gambia. One such clause deals with exemptions for government activities and in cases of pest emergency. This will, in cases of pest emergencies, exempt from required fees any pesticides donated, imported, or distributed by international aid agencies and programs. Another clause of the act deals with adultered, decomposed, and deteriorated chemicals and pesticides and their containers. The malathion left from the 1987-88 locust/grasshopper campaign may fall under this clause, if its analysis shows that it is no longer viable for use.

The act is divided into 9 'Parts,' as follows: Preliminary; Administration; Registration of Pesticides and Chemicals; Presentation of Chemicals and Pesticides; Control of Manufacture, Import, Export, Distribution, and Use of Chemicals and Pesticides by Licensing; Health and Environmental Measures; Enforcement; Offenses and Proceedings; Final Provisions. There are clauses covering each of the issues raised in SEAs, including labelling, container destruction and health issues. This new act should serve as a strong step forward by the GOTG in environmental concerns relating to pest control, if it is implemented properly, and may serve as a model for other Sahelian countries.

2.5.2 Gambian Environmental Regulations

In 1987, the GOTG wrote a National Environmental Management Act. This act was to make provision for the sustainable utilization, rational development, and conservation of natural resources; for the preservation of the national heritage; to give effect to the African Convention of Nature and Natural Resources; and for related matters. This act contains several 'Articles,' such as: Preliminary/Administration, Fundamental Principle, Definitions, Soil, Water, Flora, Faunal Resources, Protected Species, Traffic in Specimens and Trophies, Conservation Areas, Customary Rights, Research, Conservation Education, Development Plans, and Interstate Cooperation.

The 1987 act was repealed in 1993, and a new act was written. The new act, entitled "The National Environmental Act 1993," will be presented as a Bill to The Parliament on December 15, 1993. This act is much more detailed than the act of 1987; it contains 'Parts' on: General Principles; Administration; Environmental Planning; Environmental Impact Assessment, Audits, and Monitoring; Environmental Standards; Environmental Management; Pollution Control; Inspection, Analysis, and Records; Information, Education, and Public Awareness; Offenses; Judicial Proceedings; and Fulfillment of International Obligations. The act, and any resulting laws and regulations will be administered by the National Environment Management Council, chaired by the President.

Several parts of this new act will have a direct bearing on locust and grasshopper control activities. Results of the environmental assessments performed under the LOCUSTOX Project (a project set up by FAO in 1991 to study the environmental impact of locust and grasshopper control in Africa) in Senegal should be

transferred to the NEA and APMU for review for applicability to potential environmental impact in The Gambia. In the Environmental Planning and Environmental Management parts of the act, the Gambia Environmental Action Plan to be written should contain a section on preventing, controlling, or mitigating any deleterious effects on the environment due to emergency and routine locust and grasshopper control programs.
Number 27 (Management of the coastal zone, rivers, and wetlands) of Part 7 (Environmental Management) of the act will regulate introduced microorganisms and biological pesticides, thus fungi being developed for grasshopper and locust control will fall under this category. Allowances should be made for 2.5 to 5 km pesticide-free buffer zones around national parks, reserves, coastal zone, and wetlands. Part 6 of the act allows for the establishment of environmental standards for agricultural chemicals, which will include viable and unusable pesticides.

3.0 LOCUST AND GRASSHOPPER SITUATION IN THE SAHEL

3.1 Locust infestation as of November 15, 1993

The current locust outbreak originated in the traditional Red Sea coastal breeding grounds in the summer of 1992, following above average rains and a heavy vegetation flush. By July 1992, a desert locust population explosion began occurring in the coastal areas of Eritrea, Sudan, Saudi Arabia, Yemen, and Egypt. There was also localized breeding in the interior of Sudan. Additional above average rainfall in September and October of 1992 led to further upsurges of desert locust in the winter breeding areas along the Red Sea coastal areas of Yemen, Sudan, and Eritrea. Two generations of locusts were likely produced before the first swarms were observed in early November 1992. In November adults were being found at an average density of 500 per hectare. DLCO initiated spraying activities in the infested areas of Sudan and Eritrea in an attempt to control these locust populations before they reached the swarming adult stage. Unfortunately, these efforts were not sufficient and the locusts produced a third generation of semi-gregarious hoppers.

Locusts moved from the coastal areas inland to parts of Chad in the spring of 1993; from there they migrated across traditional breeding areas in Niger and Mali during June and July. They continued onward without reproducing in these areas. By early July of 1993 the first large swarms had settled in central parts of Mauritania and were beginning to reproduce. Populations increased throughout the summer into the fall. By mid October, representatives of the Mauritanian Ministry of Rural Development and Environment and the FAO declared that the infestation by desert locusts had become "generalized in all of Mauritania" with the exception of Tiris Zemmour, in the far north. Adult swarms had destroyed some irrigated rice fields in the Trarza; in the Tagant, there had been damage to bean and sorghum crops. All of the locusts present were thought to be of local origin. The locusts moved northward toward Morocco and south into Senegal, and continued late rains in Mauritania increased the likelihood for locust breeding and multiplication. Egg hatch had already occurred in the southern Inchiri and northern Trarza.

By the end of October, over 176,000 hectares had been treated in Mauritania. There were 7 fixed wing airplanes, 1

helicopter, and 7 vehicles fitted with sprayers for locust control. A total of 39 vehicles, 13 inspection teams, 20 treatment teams and 6 insecticide/equipment transport teams were in the field. FAO had supplied 24,000 liters of pesticide (primarily malathion and dursban) and the government of Algeria had donated 16,000 liters of the pesticide DDVP (dichlorvos). Problems have arisen over the donation and use of DDVP. Notwithstanding its extreme toxicity, the chemical was reported to have no effect against locusts. Further investigation determined that the DDVP was evaporating at the high Sahelian temperatures and never reached the locusts. The Mauritanian crop protection service discontinued the use of the donated DDVP after this incident and now has to find a means for disposal of the DDVP. Algeria later donated 15,400 liters of fenitrothion to Mauritania.

The Tunisian government provided 12,000 liters of malathion. Morocco donated 50,000 liters of malathion. Other donations included: EEC, $149,000; FAO, $110,000; German government, 170,000 Deutsche marks; government of Canada, 500,000 Canadian Dollars for use by FAO; the Japanese government, approximately $2.37 million for FAO anti-locust activities. Additional expected/promised financial aid includes: Islamic Development Bank, $300,000 for insecticide and equipment; FAO, an additional $200,000; the Arab Organization for Agricultural Development, approximately $8,000 for fuel purchase; and a large part of the USAID grant to FAO of $1.4 million.

As expected, desert locust swarms moved south out of Mauritania and on October 5 four swarms had moved into Senegal. By October 14, 19,655 hectares were infested and locusts had reached areas suitable for egg-laying. The government of Senegal put a monitoring and ground control operation into action immediately after the first sightings, and asked donors to contribute 138 million West African Francs (about $500,000) toward this effort. The crop protection service had 16 teams in the field, and had advised farmers to harvest their crops as soon as possible. By October 15, almost 14,000 hectares had been treated using some 9,460 liters of insecticide; and at the end of the month a total of 58,211 hectares had been treated.

By November 5, all mature egg-laying adults and hopper bands in crop lands had been destroyed. Most of the cereal crops had been harvested, but there remained valuable vegetable crops in some irrigated areas. And there was still the possibility that some larval bands existed undetected in the extensive grasslands

in northern Senegal; projections were that about 5,000 hectares of swarms could be produced from these. And the lack of information on the location, size, density, and developmental stages of locusts in Mauritania was a threat to proactive planning in Senegal. It was felt that new incursions of locusts from Mauritania would be in the form of pink, highly mobile, voracious immature adults that are difficult to control from the ground.

Donations to the GOS's requests included: FAO, $50,000; EEC, $70,000; Netherlands, $1 million to FAO; Canada, $42,000; France, $20,000; German Government, fix up trucks previously purchased; Islamic Development Bank, $250,000 expected; Italy, $200,000 expected; and part of the USAID grant to FAO of $1.4 million expected.

As of November, 1993 the situation was still calm in The Gambia, and USAID/Gambia was in dialogue with USAID/Senegal and the USAID/W AELGA Project on preventive and proactive measures. One such measure was the timely completion of this SEA. Another was the test of upcountry malathion stocks for the chemical status of active ingredient and toxic breakdown product. These analyses will provide the APMU with information on next steps to take; if the malathion contains sufficient active ingredient and does not contain dangerous levels of the byproduct isomalathion, it may be used on any locust outbreaks reaching The Gambia. If the amount of active ingredient is too low or the toxic byproducts too high, then disposal of the stocks can proceed according to a plan being developed by the MOA for all obsolete pesticides presently in The Gambia.

3.2 Agricultural Resources

Some 50 crops are grown in The Gambia; most of the major food and cash crops are subject to grasshopper and desert locust infestation, including: millet, sorghum, maize, rice, cashew, lime, groundnuts, vegetables, and cassava. Fiber crops such as cotton, kenaf, and sisal are also grown but reports of locust damage are unknown. In addition, the rangelands used for feeding livestock are vulnerable to the desert locust. Thus, a locust plague can have a major impact on the supply of meat and dairy products as well as grain, fruit, and vegetables. By destroying seeds, a locust plague can affect local crop production in subsequent years.

3.3 Grasshoppers and Desert Locusts

Grasshoppers, such as the Senegalese grasshopper, *Oedaleus senegalensis* (OSE), are a perennial problem in The Gambia. Economically damaging populations can be found somewhere in The Gambia almost every year, but widespread outbreaks are sporadic, since this species depends on optimal rainfall and temperature conditions for rapid population build-up. Populations will build in grasslands, and will remain there as long as the grasses remain green. As the Intertropical Convergence Zone (ITCZ) moves south, and rainfall diminishes, the pastureland grasses will dry, inducing the grasshoppers to move in a southerly direction. If there are crop lands in the area, the grasshoppers will move into these green areas. Crop damage can be dramatic, but is usually sporadic and localized.

The Senegalese grasshopper is considered to be the most destructive acridid in The Gambia, with two or three generations per year. OSE eggs may remain viable for two or three years during periods of extreme drought. In contrast, eggs of most grasshoppers and locusts, without moisture, lose viability in a few months. OSE habitat is governed by rainfall (200 to 1000 mm annually, occurring almost entirely within the summer months), and the presence of light sandy soil and the availability of grasses and grains.

The Senegalese grasshopper exhibits some migratory-like behaviors, such as the formation of loose hopper bands and mass movement of adults. However, unlike the desert locust, there are no morphological changes and the OSE does not surge into 'plague cycles' that involve large regions. The migration pattern follows the northern progression and southern retreat of the ITCZ weather system. Hatching of the first generation will occur 10-12 days following early summer rains of 25 mm or more. Immature grasshoppers pass through five instars and become adults within about 30 days following hatching. In The Gambia, under normal conditions, about 75% of this first generation will emerge within the 75-1000 mm annual rainfall zone. A second generation occurs in mid-summer, and in late summer, a third generation emerges. The adult progeny of this third generation can migrate south with the ITCZ. Eggs laid along the way enter obligatory diapause (a dormant period). Most egg laying seems to occur in the zone with 750-1000 mm of rainfall.

A somewhat similar infestation pattern occurs throughout the length of the Gambia River except that with irrigated multiple cropping regimes and flood recession agriculture, crops are threatened most of the year. Grasshopper infestations normally

consist of a complex of species, with one or more dominant depending on the vegetation types and habitat. It is not possible to limit control to the Senegalese grasshopper, but intervention by USAID will be limited to times and locations at which the Senegalese grasshopper is dominant.

Other nonmigratory species of grasshopper, such as the variegated grasshopper, *Zonocerus variegatus*, can be important in some parts of the country. Outbreaks of this species can cause severe damage to gardens and field crops. A number of other grasshoppers and locusts are of agricultural importance and are covered in the PEA. Other grasshopper and locust species are not expected to become a serious problem in that they would exceed the capacity of the APMU. Thus, no intervention by USAID/Gambia is expected for any locust or grasshopper species except the desert locust and the Senegalese grasshopper, and possibly the African migratory locust. Assistance to the APMU for operations involving these pests will primarily be in training, operations planning and preparation, survey, and early intervention.

The primary locust in The Gambia, and throughout the Sahara and Sahel, is the desert locust, *Schistocerca gregaria*. The African migratory locust *Locusta migratoria migratorioides*, can also be an important outbreak pest.

The Gambia lies within the desert locust's outbreak area, but it is not considered to be a critical recession breeding habitat in the context of outbreaks and plagues. The pattern of infestation of locust swarms in The Gambia suggests that the immediate source is Senegal, Mauritania and/or Mali. The ultimate origins can be northern Sahelian breeding areas, the Horn of Africa, or even the Arabian Peninsula and India.

Although past anti-locust intervention has largely been in the emergency control of swarms to protect crops, this approach is costly and often ineffective in overall impact. Further, such intervention can be environmentally costly because of the large quantities of pesticides used. A more reasonable approach, and the strategy recommended by this document, is preventive control. This relies heavily on good survey, immediate intervention in limited areas, and control actions aimed at nymphal control, rather than swarm control.

The nature of locust behavior makes preventive actions in breeding areas desirable. The maintenance of populations in a recession state with minimal application of pesticides should be

the strategy of choice. The key breeding areas located in Mauritania, Mali, Niger, Chad, and the Horn of Africa are reported to be uncultivated lands. Despite sparse human habitation, some of these areas may be ecologically sensitive and should be protected. The preference for using a low volume of pesticide or, if available, a biological control agent in a preventive program should be encouraged.

3.4 Locust and Grasshopper Management - Overview

3.4.1 History of Locust Campaigns

The longest recorded desert locust plague began in 1941 and lasted, with one short lull, more than twenty years. This plague began in India. In 1940, the Indian Locust Warning Service reported locusts invading from the west. By the summer of 1941 the plague had spread to Egypt, Sudan, and Eritrea. Due to war, preventive actions could not be taken and the locusts could not be controlled in Eritrea. Within weeks the locusts invaded British Somaliland, Somalia and eastern Ethiopia. The British mounted a crop protection campaign against this plague with the assistance and cooperation of the World War II Allies. The description of the campaign that follows is summarized from The Desert Locust (1972) by Stanley Baron.

An Interdepartmental Committee on Locust Control was established in England, to ensure that every department of the government could be utilized as needed in the control operation. Control operations began in Sudan in 1941. The plague temporarily subsided in 1947. Applications of sodium arsenate and BHC were used for the first time against locusts. There is no record of the health and environmental effects of applying these two highly toxic chemicals. Only Eritrea and Sudan sustained major crop losses.

The locust situation in Eritrea, Sudan, and other Red Sea coastal areas was worsened by the system of cultivation dependent on seasonal rains and floods. This is still the case today (see section 3.7 "Cultural and Biological Management").

In October 1948 renewed locust outbreaks were reported from Saudi Arabia. By 1949 the swarms had spread back to India, Pakistan, and Iran. Campaign plans by FAO could not be implemented due to a lack of funds. The estimated cost of the proposed campaign was $1.5 million. According to Baron, it was

the failure to take action in 1948 that led to the next ten years of locust disasters.

The worst of these disasters was the 1958 infestation that destroyed 167,000 metric tons of grain in Ethiopia, enough food to feed 1 million people for a year. The U.S. supplied Ethiopia with 20,000 metric tons of grain. Still, it was necessary for the Ethiopian government to make large scale tax remissions to afflicted farmers. As a consequence, Ethiopia's entire economy was set back. In 1963, the locust plague ended. It is not known if the control efforts contributed to the end of the plague, or if weather conditions were sufficient to stop the plague.

In November 1967, heavy rains initiated a new round of heavy locust breeding in Eritrea and Sudan. The situation worsened when locusts from southern Arabia flew into Eritrea. FAO issued a warning on 27 December 1967 that 30 countries were in danger of locust plagues if there was successful breeding in the spring of 1968. A coordinated control effort by the Desert Locust Control Organization and the Ministries of Agriculture in affected countries brought the plague to an end in 1969 using dieldrin and BHC. Dieldrin, BHC, and all other chlorinated hydrocarbon insecticides are no longer used for locust control, due to their persistence and the environmental hazards that they pose.

Twenty years passed as the locusts remained in remission, then in late 1986 desert locust populations in Ethiopia (including Eritrea) and Sudan developed to plague status. In 1987, swarms reached across the Sahel to Mauritania, then moved north to the Maghreb. By 1988, locusts moved south and invaded Senegal, The Gambia, Guinea Bissau and Cape Verde. Apparently weather conditions, in addition to the emergency control measures, caused the primary decline in desert locust activity in early 1989, and a large storm system blew many of them out into the Atlantic Ocean.

Large outbreaks of grasshoppers, including the Senegalese grasshopper, occurred and were controlled by the Crop Protection Service in 1986 and 1987 in The Gambia. In 1986, spraying and some pesticide spill along parts of The Gambia River resulted in a large fish kill. This event effectively sensitized the GOTG authorities on the detrimental effects of pesticides, and no further large scale spray operations took place over the Gambia River.

3.4.2 Crop Loss Assessment

All crops in the region are at risk. Crop loss assessments should be a part of any future locust and grasshopper control campaigns, especially considering the potentially high environmental costs associated with control in a country that contains so much wetland and coastal area, and depends on these resources for tourism, fish and cash shellfish production.

Crop loss information is needed to guide both The Gambia APMU and USAID (as well as other donors) in the level of response which may be needed. Once the infestation levels can be related to potential yield loss, management operations can be more realistically planned. USAID/W has supported crop loss assessment research in Mali and Chad, as well as collaborative work with other donors and regional research organizations.

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

Crop losses will vary geographically, with intensely damaged fields occurring adjacent to untouched fields. Undoubtedly, the distribution and success of control efforts among the regions of The Gambia in proportion to infestation levels are not uniform from year to year. Good crop productivity data are already available. If estimates of locust/grasshopper infestations and efficacy of control efforts were to be kept over a period of years for each region, a much better estimate of cost effectiveness of controls could be made. This SEA strongly urges that such data be compiled and analyzed.

3.5 Locust Management Operations

3.5.1 Regional: OCLALAV

OCLALAV was originally organized as a regional locust, grasshopper and bird monitoring and control organization for the

Sahel. Subsequent funding problems caused OCLALAV to significantly change its mandate. Presently, OCLALAV serves as an information source for locust, grasshopper, and bird activities in the 10 member countries, but OCLALAV is no longer operational with regard to survey and control. Most of their equipment and resources have been liquidated. There are two OCLALAV officers remaining: a Director General and a Technical Director. New executive officers are appointed every 1 years, and elections for new officers were held in October, 1993 at a meeting of OCLALAV convened in The Gambia.

Operational and coordinating regional locust/grasshopper control organizations exist for North African countries, with the Force Maghrebian d'Intervention (FMI), and for East African countries, with the Desert Locust Control Organization (DLCO). A regional locust and grasshopper control organization with a strong coordinating role for the Sahelian countries is lacking at this time. Most of the operational functions within each country are presently undertaken, with reasonable success, by the national crop protection services. However, there is no group that can go across borders for control.

3.5.2 Local: The Gambian Crop Protection Service

The Gambian Crop Protection Service was largely disbanded and revamped following the locust and grasshopper campaigns of the late 1980s. From this, the Agricultural Pest Management Unit was born. This unit was formed in 1991 to provide technical expertise to various divisions within the Ministry of Agriculture, and it is responsible for locust and grasshopper control in The Gambia. A list of its resources is provided in Appendix E.

3.5.3 Village Brigades

Village brigades were used with some success in the 1986-1989 locust/grasshopper campaigns. As many as 32,000 Gambian farmers were used, primarily in the application of dust pesticide formulations effective against hopper bands. Many of these farmers received training from trainers who were trained through the Office of Foreign Disaster Assistance and AELGA. As alternative methods are developed for locust and grasshopper control, retraining of these farmers will become necessary. Local crop protection agents should be used to the maximum extent

possible to avoid high external consultant costs.

3.5.4 Crop Protection vs. Strategic Control

The goal of crop protection is to destroy locusts or grasshoppers near or in crops during plagues or outbreaks, while strategic control is an attempt to prevent plagues by managing sexually immature desert locust or grasshopper populations in major breeding areas. This SEA recommends that strategic control be implemented whenever possible. If strategic control is successful, then locust plagues will be prevented and there will be no need to implement crop protection. The USG should urge FAO to put in place a preventive control plan for the "central locust region," that is, the area surrounding the Red Sea and the Horn of Africa, where desert locust plagues generally start.

Integrated pest management (IPM) tactics will be important components of a strategic control program. An IPM program uses a variety of methods to keep locust populations below levels where economic loss or, in the case of desert locusts, a major population surge in critical breeding habitats, is imminent. Chemical pesticides should only be used when necessary, thereby reducing the environmental impact of locust control operations, costs, and exposure to handlers.

To apply pesticides at optimal times, it is necessary to survey for locusts early in the season with trained personnel and proper equipment. A successful locust survey program requires survey teams that:

1) know the physical and temporal distribution of locusts;

2) monitor environmental conditions which could lead to increased numbers of locust;

3) conduct vulnerability assessments of the crops threatened by locusts;

4) have access to pest management support resources that can be rapidly mobilized for control, such as: chemical or biological pesticides, safety and application equipment.

The APMU should ensure that each of their stations is prepared to respond to a locust infestation. Adequate preparation includes: radio communication, vehicles, application

equipment, clean protective clothing and safety equipment, and a sufficient amount of the proper pesticides carefully stored and ready for use (a listing of the resources available to the APMU is given in Appendix G). Strategic control can only be effective when accurate, up-to-date records of survey and spray operations are maintained. Such records should include:

A. Survey

1) Where the survey was conducted (longitude, latitude)
2) When the survey was conducted
3) How the survey was conducted
4) The density of locusts (average no./m3)
5) Locust stages present, relative numbers of each
6) crops affected, types of vegetation
7) Climatic conditions (temp, wind, soil moisture)
8) Magnitude (no. of hectares) of infestation

B. Spray

1) Where the pesticide was applied
2) What kind of pesticide was applied
3) The application rate and area covered
4) When the area was treated
5) Crops and vegetation treated
6) Results of follow-up survey to see the effect of spraying: the percent of locusts that were killed by the operation
7) Non-target effects, other animals killed

3.6 Pesticide Management

In 1990, the crop protection service had pesticides remaining from the 1980s locust and grasshopper campaigns. These consisted of a small amount (800 liters) of carbaryl ULV, and a relatively large amount (34,000 liters) of malathion, both of which were donated by the USG. As of November, 1993, the MOA had malathion 96% ULV stored at 4 sites in The Gambia: Sapu, Jenoi, Bwian, and Yundum. A pesticide sampling team composed of the author of this document, a representative USAID/Gambia, and the Deputy Head of the Gambia APMU visited the 4 sites and sampled the malathion for eventual testing.

The Environment Unit of AFR/ARTS/FARA had, earlier in the year, supplied USAID/Gambia with a pesticide sampling kit

(supplied by the GTZ Pesticide Testing Service) composed of: sample bottles, labels, pipettes, rubber gloves, and sample recording forms. The AELGA Project supplied the technical assistance resource person to sample the malathion. And the APMU provided safety goggles and respirators for the sampling exercise.

The following is a description of the pesticide storage conditions as of November 1993, and sampling methodology at each of the 4 sites visited by the pesticide sampling team:

Jenoi

The site at Jenoi is a large pesticide storage building. This building has all of the characteristics of a proper storage facility, such as entirely enclosed with cement floor, good ventilation, locked doors, warning message posted, running water nearby for wash-ups, and was isolated away from other buildings. The building was shaded by a large tree, providing additional protection against heat build-up inside. The interior of the building had a strong pesticide smell, and the floor had some small piles of material that were likely dust pesticide formulations of unknown origin and composition. Any future teams entering the building would be wise to wear rubber boots to avoid exposure to these dusts. In addition, there were oily spots on the floor that are likely inevitable pesticide spills. Any future pesticide disposal effort should attempt to sweep up and package the dusts and oil-soaked dirt on the floor to be detoxified and/or disposed of. There were other, non-US donation pesticides being stored in this building.

The US-donated malathion being stored at this site is in good condition. All of the malathion is in 200 liter (50 gallon) factory drums. Only one of the 18 barrels stored here had been opened, and had about a third of its contents remaining; the rest all had the factory seals intact and were full. One of these sealed barrels showed signs of leakage near the rim, but was standing upright, so that the leak was facing up and no pesticide was draining out. The rest of the sealed barrels were clean and dry. If these barrels are to be stored for a longer period of time, they should be elevated off of the floor on wooden palates. Three of these barrels, the opened one and two sealed ones, were sampled. The barrels were rolled back and forth on the floor to mix the contents before sampling.

Sapu/Murtabeh village

Here the pesticide barrels are being stored in the open. The positive aspects are that the barrels are shaded by a large tree, are elevated off of the ground on small wooden logs, and are well ventilated. There was no pesticide odor and no signs of pesticide spill on the soil. An old village chief guarded the barrels. There were 18 barrels (200 liters each) here, one of which had been opened and the other 17 had factory seals intact. All barrels were clean and dry. Again, 3 of the barrels were sampled, after thorough mixing. There was a newly constructed pesticide storage shed nearby but it was being used to store something else. There were no first aid kits, lime, or shower facilities on hand here.

Bwiam

As with the site at Jenoi, there is a properly constructed and maintained pesticide storage building at Bwiam. There were 11 barrels (200 liters each) of US-donated malathion being stored here, all of which had factory seals intact. The barrels were clean and dry and there was no pesticide odor in the building. Also in the building were wooden honeybee supers (hive drawers) and some pesticide application equipment. Here only 2 of the barrels were sampled. If these barrels are to be stored for a longer period of time, they should be elevated off of the floor on wooden palates.

Yundum

The one and only 200 liter barrel left at Yundum had been opened and material had been stolen for construction termite-proofing, according to MOA records. By the time our team investigated the site, all that was left were large oil-spots on the soil where malathion had been spilled during dispensing. There was a strong smell of malathion at the site and the barrel was gone, presumably to be salvaged for the metal.

Next Steps

The 8 sample (20 ml each) bottles full with malathion, and accompanying sample recording forms, were sent to Chemspec International, Incorporated in the US, the same laboratory that tested Morocco's malathion stock 2 years ago.

The analysis was not complete at the time of this

assessment, but once done, should indicate the amount of active ingredient remaining in the barrels, and the amount of toxic breakdown byproducts, such as isomalathion, present. If the level of active ingredient is sufficiently high and the toxic byproducts low, then a recommendation may be made that the APMU use the pesticide on this year's grasshopper or locust problems, if needed. If the opposite is true, then the APMU may need to look into methods of disposal. There is a tentative plan by the Dutch to repackage obsolete pesticides for shipment to Holland. USAID/Gambia should continue to monitor the situation closely.

All other pesticides held by the APMU were purchased or donated during the 1970s and early 1980s for pests and agricultural problems other than, and in addition to, locusts and grasshoppers.

The APMU should bring stocks of lime to each of the pesticide storage buildings for use in neutralizing organophosphate pesticide spills. All of the buildings had a water source nearby for washing, but none had shower facilities, per se. First aid kits were present at each of the storage facilities. None of the facilities had posted contingency plans for pesticide spills. The APMU should develop and post such contingency plans.

3.7 Cultural and Biolcgical Control Tactics

IPM utilizes all available control methods to achieve the most economically and environmentally sound management program. USAID supports the implementation of IPM tactics whenever possible. IPM is not an alternative to chemical pesticides; instead it is an integration of methods which may reduce the use of pesticides by employing them more judiciously. Some examples of IPM techniques are: determination of rational intervention thresholds and correct timing of sprays based on pest population dynamics, mechanical control, and use of biological control agents. Among the biological control agents with the potential for use in locust management are: the bacteria Coccobacillus acridiorum d'Herelle; the fungal pathogens Beauveria bassiana and Metarhizium; various microsporidia in the genus Nosema; and some nematodes. Of these, Beauvaria and Metarhizium currently hold the most promise. Biocontrol will be most useful in strategic control efforts and less useful during crop protection emergencies. These microbial biocontrol agents should be able to keep recession locust populations, such as those in the Red Sea

coastal areas, at low enough levels to avoid major outbreaks.

Desert locust eggs can also be destroyed by cultural control, such as surveying for and digging up egg pod fields. If egg-laying sites were discovered during desert locust invasions, the soil could be turned to expose eggs to the sun and to predators. This practice is apparently quite effective for eliminating locust eggs, and is utilized by the crop protection services in several West African countries (Mali is one good example). The difficulty lies in finding the eggs and egg pod fields and training in doing this may need to be provided. Destruction of locust eggs could involve village brigades.

Farmers often use mechanical methods to destroy hoppers and adults. They wait until early morning or late afternoon, when the locusts are roosting and likely to be highly concentrated. The control consists of beating the locusts with tree branches and if the locusts are highly concentrated this can be reasonably effective. Occasionally hopper bands are trapped in trenches dug in their path, and at times are burned as well.

Among the cultural practices which discourage locust plagues are: use of irrigation to avoid dependence on seasonal rains and floods for growing crops, weed control, and destroying abandoned fields (e.g., by burning). To prevent erosion, or maintain the water table it may be desirable to have plant cover in an abandoned area. In such cases, plants which locusts do not favor could be planted in the area.

3.8 Safety and Human Health

3.8.1 Public Awareness

It is important that the GOTG monitor the effects of pesticides on human health and the environment. The medical community and pesticide applicators need to have an understanding of the potential hazards of pesticides, of the precautions to prevent mishaps, and of the steps taken to solve problems associated with pesticide mishaps. Before applying pesticides in an inhabited area, pesticide handlers and the general public should be educated on pesticide safety. The Gambian public must be informed that pesticides are dangerous and that empty pesticide containers should not be used for food or water storage. The APMU should ensure that used pesticide containers do not fall into the hands of the general public. People should

also be warned against eating locusts in areas where insecticides are being sprayed. In Tunisia and other countries, public warnings against locust consumption discouraged people from eating locusts in treated areas. This information can be spread through newspapers, posters, radio, television, and public lectures. A good public information program would include:

1) warnings against eating pesticide-treated locusts;

2) information on specific pesticides and labels;

3) safe methods of pesticide transport and storage;

4) measures in cases of container leakage;

5) conditions for pesticide use;

6) safe use of application equipment;

7) prevention of pesticide poisoning.

8) information on re-entry and residual intervals for pesticide-treated crops

3.8.2 General Pesticide Safety Concerns

Pesticide misuse and improper storage present hazards to the health of the general public and to the environment. Pesticides should be stored away from humans and animals. Unwanted or leaking pesticides must be repackaged or disposed of as soon as possible. The new Gambian pesticide regulations should be enforced once they have been passed into law. The APMU has dealt with the problem of used pesticide containers by either storing them or by puncturing, crushing and burying them. It was noted, however, that in the past some of the containers have fallen into the hands of the general public. This type of incident should be entirely avoided in the future.

3.8.3 Handler & Applicator Safety

USAID supports pesticide safety training in Africa. Pesticide handlers and applicators working for the Gambian Ministry of Agriculture should be trained in pesticide safety. Every U.S.-funded pesticide donation should be accompanied by safety equipment for the following operators: 1) workers and

handlers responsible for shipping, storage, loading and mixing, 2) applicators (farmers, technical agricultural agents, crop protection agents, and public health agents engaged in treatment activities), and 3) pilots exposed in spite of protective measures. The handling of the pesticides from the point that they arrive in the country to the time they are formulated, loaded and used in the field should be overseen by properly trained pesticide handlers. Some MOA staff have received training in handling and use of pesticides, but refresher courses will be needed. Safety clothing (e.g., coveralls, rubber boots, rubber gloves, respirator) is often not used, primarily because it is uncomfortable to wear at high temperatures, and also because much of the available equipment is old and unusable. There is a need for new safety equipment. There continues a need for safety equipment that is comfortable to wear at high temperatures.

Although farmers often do not use safety equipment, the exposure to farmers is considered low since their fields are generally only sprayed once or twice a year in an outbreak; repeated exposure does not occur. Pesticides are supplied to farmers immediately prior to application and are not stored by the farmers. Chemical storehouse workers generally use safety equipment consistently, thus reducing repeated exposure. Lists of safety equipment held by the MOA are included in Appendix G.

Trained Gambian Ministry of Agriculture personnel are encouraged to continue to work with farmers and village brigades in "Train the Trainer" programs. This type of training allows essential information on pesticide safety and application to reach everyone working with pesticides. USAID encourages this type of training. The AELGA Project has provided and facilitated training for APMU agents in the past. For example, in 1987, a regional workshop on the training of trainers in locust and grasshopper control was held in the Gambia. A workshop on greenness map uses and limitations for locust control was also held in The Gambia in 1987. In addition, most of The Gambia APMU staff received formal training directly through AELGA as well as in FAO, OCLALAV, and USGS training events sponsored in part by AELGA. Well over 10,000 copies of publications and documents have been produced and distributed by AELGA, and they now form a very visible, ubiquitous part of African crop protection service's and The Gambia's APMU offices and laboratories.

3.8.4 Monitoring of Human Exposure

The Gambian Ministry of Agriculture has, in the 1986-1989 locust/grasshopper campaign, performed blood acetylcholinesterase (AChE) tests to monitor symptoms of pesticide poisoning to those operators listed in section 3.8.3 above. Symptoms of pesticide poisoning include weakness, loss of muscle control, shallow breathing, nausea, dizziness, vomiting, and abdominal cramps. A diagnostic symptom for determining the level of exposure to organophosphate (OP) pesticides is AChE inhibition. Testing all pesticide handlers for blood AChE inhibition should be a part of all U.S.-funded pesticide operations that use OP pesticides. This is a fairly simple and inexpensive test, and it can be performed by trained health workers in the field. The background AChE level for each person involved with OP insecticides must be determined before OP exposure. Then testing should be performed at intervals throughout the season to ensure that no worker is being overexposed to OPs.

If an operator is found to be overexposed to OP, it is recommended that the antidote, atropine, be administered immediately. The operator should then remove and wash his/her clothes and bathe with plenty of soap and water to remove pesticide residues. The operator's breathing and pulse should continue to be monitored for several hours following treatment.

3.8.5 Disposal of Drums and Obsolete or Banned Pesticides

Pesticide containers are kept under the supervision of the APMU agents and guards. Empty barrels are stored at plant protection bases where they can be destroyed or recycled. Destruction should include neutralizing (triple rinsing with kerosene), puncturing, crushing and burying the empty barrels in uninhabited places where water table is low, and where no aquifers or water supplies originate. The kerosine rinsate should be disposed of in the same manner, away from habitation.

Another option for barrel disposal could be recycling; this would involve rinsing, relining, and relabeling them for use in storing more pesticides. Otherwise they could be washed with kerosine and smelted down to produce other metal products. Most African countries do not have the facilities to do this. Barrels should not be cut up and used for other purposes such as construction materials; this use has occurred in the past in most

African countries and NEA and APMU officials should remain diligent in guarding against this. And used drums should **never** be used to store water, food, or animal feed.

Pesticide disposal is problematic at this time due to a paucity of viable options. At the very least, the outdated and banned (in the USA) pesticides should be stored under proper conditions until disposal options become available. Such conditions include a well ventilated, dry, shaded, cement-floored facility, with clear labelling of all pesticides. A list of obsolete and banned pesticides held by the APMU is included in Appendix G. Most of the chemicals being held are known and labelled and stored properly, and were donated during the 1980s for locust or grasshopper control. A closer examination of APMU's records will be needed to determine the donor and source of all of the obsolete and banned pesticides.

The burial of pesticides in a landfill does not appear to be a viable option for The Gambia due to the relatively high water table found throughout the country. The only environmentally acceptable options for pesticide disposal at this time are sending the pesticide back to the manufacturer or to a firm that safely disposes of chemicals through treatment or destruction. These options, however, can be very expensive. Countries with toxic wastes may need to wait until less expensive alternatives are found. In the meantime the chemicals should continue to be stored properly and re-drummed if present containers are leaking.

4.0 ENVIRONMENT

4.1 CLIMATE

The Gambia experiences 5 months, June to October, of intense rainfall and 7 months of dry season weather. The ITCZ, bringing systems from the Atlantic, and influencing the weather and locust situation across the Sahel, moves north over the Sahel from May to September, and the rains follow to the south of it. This movement brings a rain band north into locust breeding areas during the summer.

Rainfall produces sufficient soil moisture for locust egg hatch. As of October 1993 rainfall was heavy in major locust breeding areas in Mauritania. This is expected to give rise to more locust outbreaks which could move south into Senegal and The Gambia.

Temperatures vary widely throughout The Gambia. In the west, the Atlantic Ocean moderates the temperature, with highs of 30 degrees Celsius; inland the seasonal variations are more extreme, with highs of 40 degrees Celsius.

4.2 CRITICAL HABITATS

The Gambia has some 40 forest parks, one nature reserve, and three national parks. The Gambia is home to over 500 species of birds that inhabit the rich wetlands surrounding the Gambia River. Since so much of The Gambia is composed of wetlands, extra care must be exercised in the use of pesticides for locust and grasshopper control. Information on Kiang West National Park was extracted from a Biodiversity Support Program document produced in 1990. The following (Table 1) references protected sites in The Gambia.

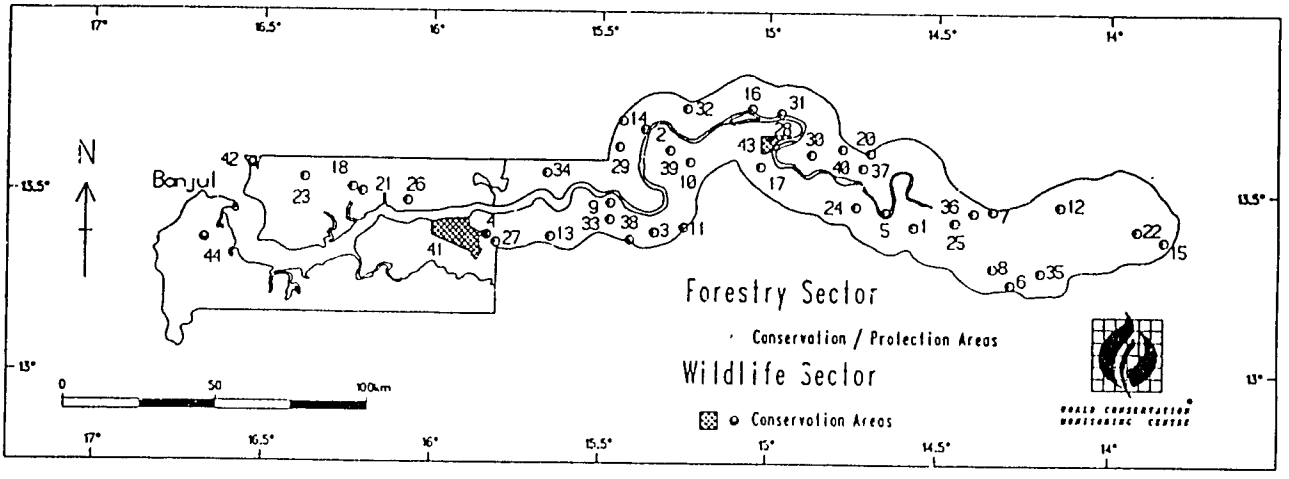
Table 1: **GAMBIA - PROTECTED SITES**

National/international designations Name of area and map reference (see Fig. 1)	Management area (ha)	Year notified
Forest Parks		
1 Bankuba	850	1954
2 Belel	405	1954
3 Beri Kolon	1,052	1954
4 Brikama	356	1954
5 Dobo	704	1954

Table 1 continued: Protected Sites in The Gambia

National/international designations Name of area and map reference (see Fig. 1)	Management area (ha)	Year notified
6 Gambisara	308	1954
7 Hamdulai	112	1954
8 Helakunda	101	1954
9 Jabisa	16	1954
10 Jamara	579	1954
11 Jambangkunda	356	1954
12 Jeloki	858	1954
13 Jollifin	439	1954
14 Jumbo Yaka	227	1954
15 Jundaia	437	1954
16 Kahi Badi	1,485	1954
17 Kaolong	2,379	1954
18 Kasaywa	202	1954
19 Kenowore	67	1954
20 Kiberi	389	1954
21 Kumadi	283	1954
22 Kusun	316	1954
23 Lohen	95	1954
24 Madina Demba	2,373	1954
25 Mamato Konko	431	1954
26 Marike	174	1954
27 Mutaro Kunda	809	1954
28 N'Jassang	2,347	1954
29 Ngeyen	612	1954
30 Ngongonding	1,250	1954
31 Niani Maru	607	1954
32 Njau	364	1954
33 Nyanaberi	1,198	1954
34 Pakala	1,161	1954
35 Sabbi	73	1954
36 Sakaru Dalla	261	1954
37 Sao Frest	728	1954
38 Se-Ulumbang	529	1954
39 Sikunda	445	1954
40 Tanu	2,667	1954
National Parks		
41 Kiang West	11,000	1987
42 Niumi/Sine Saloum	4,940	1987
43 River Gambia	2,500	1978
Nature Reserve		
44 Abuko	107	1968

Figure 1: Protected Ecologically Sensitive Sites in The Gambia



4.2.1 National Parks

This SEA identifies the following parks, which are shown on Map (Figure 1) above, as critical habitats:

1) Kiang West National Park: this area was officially declared a park in 1987. The park comprises about 11,000 hectares and crosses several ecological habitat types, including riverine, tall mangrove, salt marsh, and upland savanna woodlands. Two endangered mammal species occur in the park, the red colobus monkey, and the manatee. Caracal, serval, bushbuck, common duiker, warthogs, and spotted hyenas are also found in the park. In fact, 44 species of mammals are currently found in the park. Both the Nile crocodile and the African python are also found in the park, and are considered endangered. Other reptiles include the royal python, Nile monitor, sandsnakes, spitting cobra, hinge-backed tortoise, and puff adder. Two hundred and fifty bird species have been sighted in the park. The park contains 12 species with a very local distribution and are difficult to observe elsewhere in The Gambia. One threatened species, the brown-necked parrot, breeds in the park. Several species of fish, as well as oysters and shrimp, inhabit the aquatic parts of the park.

2) River Gambia National Park: designated in 1978, this area is the oldest national park in The Gambia. Covering an area of 25009 hectares, this park comprises a group of five islands in the River Gambia. It is home to warthog, hippos, savanna baboon, and aardvark.

The area is also an important site for a chimpanzee rehabilitation scheme.

3) Niumi/Sine Saloum National Park: designated in 1987, this park covers an area of 4940 hectares. It is a cooperative conservation exercise with Senegal, supporting valuable mangroves and wetland, with breeding waterbirds.

4.2.2 Nature Reserve

This SEA identifies the following reserve as a critical habitat:

Abuko Nature Reserve: established in 1967, this reserve is home to the rare Sitatunga antelope, Nile crocodile, western red colobus monkey, Grivet monkey, serval, and 201 species of birds. Several of the bird species are rarely seen in other parts of The Gambia; such species include Vereaux's eagle owl, the violet touraco, and the green-crested touraco.

4.2.3 Wetland Resources and Aquatic Habitats

This SEA identifies the following wetland resources as critical habitats:

1) Main river catchment basins: The major river catchment basin in The Gambia is the Gambia River. There are no major tributaries to this river in the Gambia, but hundreds of small streams flow into the Gambia River along its entire length. The river originates in the mountainous regions of Guinea and is tidal along its entire length.

4.2.4 Migratory Bird Flyways

Each year birds from Europe migrate south to parts of Africa for the winter. One major bird migration flyway crosses over The Gambia (see Map, Figure 2, below). Some of the birds stop over on their way further south to other west African countries, while others actually overwinter in parts of The Gambia. While it would be impossible to list all of the species involved and the general route that each takes, suffice it to say, birds do

overwinter and large concentrations, and overwintering birds and their habitats should be avoided while spraying. The APMU and USAID personnel and contractors involved with the locust control efforts should be in touch with the Gambian NEA to learn of any major concentrations of overwintering birds, the times that they are likely to be present, and their primary feeding and roosting areas. Locations that are sprayed should also be monitored for bird kills and toxification.

None of the parks, reserve, or wetlands listed above are breeding areas for locusts. This SEA recommends that the Gambian Government declare these areas and wetlands to be critical habitats where no pesticides can be applied for locust control or any other agricultural reasons. This SEA further recommends that 2.5 to 5 km buffer zones be established around the parks, where pesticide applications would be prohibited except in emergency situations. The APMU should consult with the NEA frequently to determine where locust control activities may overlap with valuable natural resources such as wildlife and migratory birds. Pesticides should never be applied within the park itself unless there is a direct threat to human lives (e.g., for malarial mosquito control, or tsetse fly control).

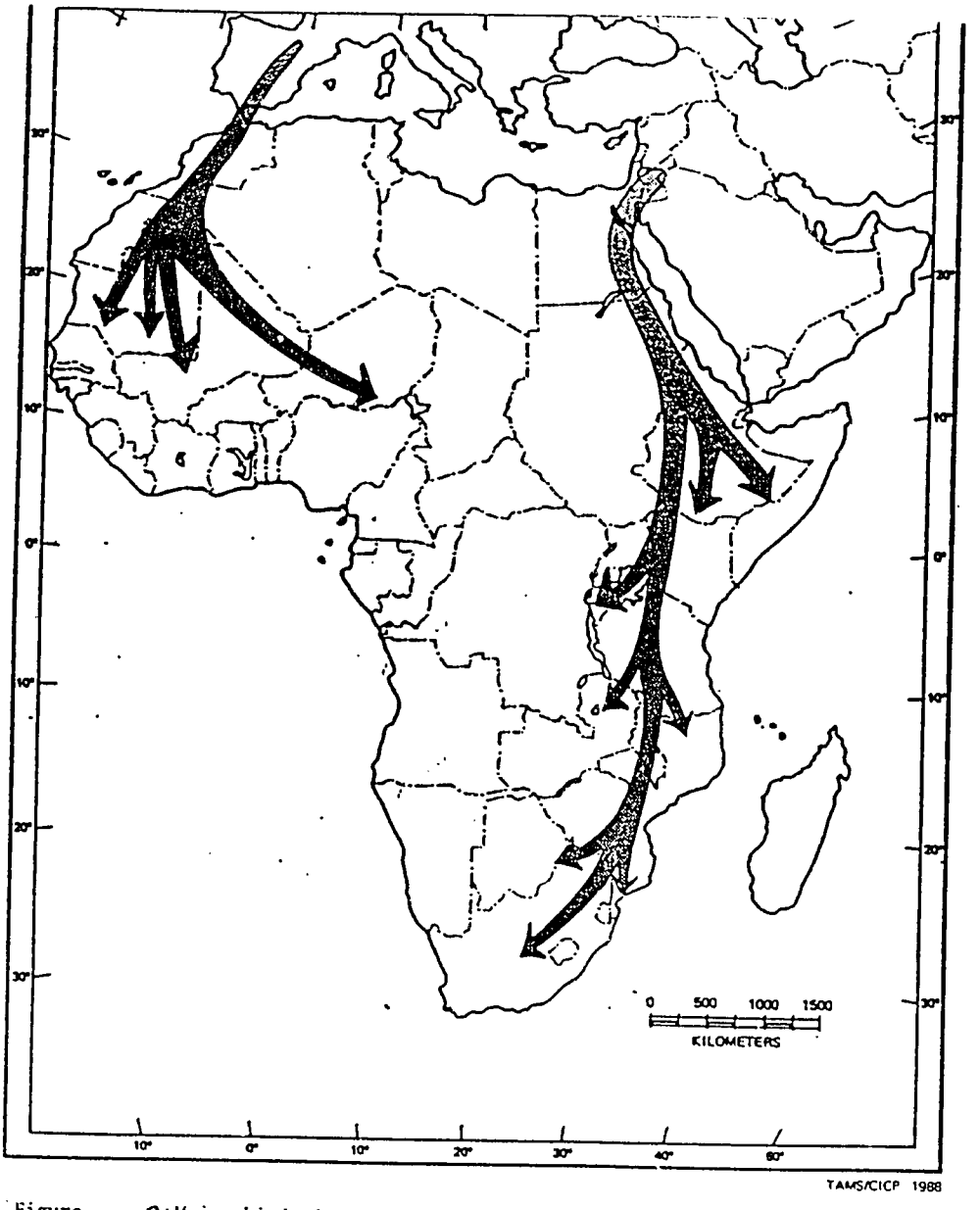


Figure 2: Major bird migration flyways. Diagram shows typical flyways as drawn from many sources.

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APPENDIX A. LIST OF PEOPLE CONTACTED FOR THIS SEA

Government of The Gambia

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Ministry of Agriculture, Department of Agricultural Services, Agricultural Pest Management Unit

Bakary Trawally - Head
Momadou Kanteh - Deputy Head

USAID/The Gambia

Gary Cohen - Agriculture and Natural Resources
Omar Jallow - Agriculture and Natural Resources

USAID/Washington

Dr. Allan Showler - Entomologist and Technical Advisor to the AELGA Project, AFR/AA/DRCO
Dr. Yeneneh Belayneh - Ecotoxicologist, AELGA Project, AFR/AA/DRCO
Dr. Walter Knausenberger - Entomologist, AFR/ARTS/FARA

Other Donor Organizations

FAO

E. O. Bayagbona

APPENDIX B. ANALYSIS OF PEA RECOMMENDATIONS

BASIC PRE-CONDITION OF PROGRAM

1. USAID should continue its involvement in locust control. Operationally, the approach to be adopted should evolve toward Integrated Pest Management (IPM).

This recommendation should be applied in the context of the specific needs of The Gambia. USAID/The Gambia supports the use of IPM tactics in the management of locusts, as well as other insect pests. USAID should also encourage the Peace Corps to get involved in locust control in The Gambia. Peace Corps Volunteers in The Gambia could:

1) Teach pesticide safety
2) Conduct research on biological control of locusts
3) Teach agricultural techniques to nomads that would reduce the number of locust breeding habitats
4) Teach cultural locust control techniques
5) Teach the principles of IPM

INVENTORY AND MAPPING PROCEDURES

2. An inventory and mapping program should be started to determine the extent and boundaries of environmentally fragile areas in The Gambia.

USAID should encourage the GOTG to establish areas where pesticide use is banned or limited, and to designate such areas on official maps (see section 4.0).

3. A system for dynamic inventory of pesticide chemical stocks should be developed.

The Gambia has an accumulation of degraded pesticides. Pesticides are often transported, applied, and disposed of without proper caution. Improvements in the system for managing pesticide stocks must be implemented to protect human health and the environment. Proper storage will reduce pesticide degradation. Most of the chemicals being held by APMU are known and labelled and stored properly, and were donated during the 1960s, 1970s and 1980s for locust control (there are a few chemicals present for rodent and vector control).

4. USAID should take an active role in assisting host countries in identifying alternate use or disposal of pesticide stocks.

A plan for disposal of obsolete pesticide stocks has been drafted by the APMU with the support of the Dutch. Additional activities should include the periodic testing of stored pesticides stocks to insure that the material is usable. The future accumulation of unwanted pesticides should be minimized. The only environmentally acceptable options for pesticide disposal at this time are sending the pesticide back to the manufacturer or to a firm that safely disposes of chemicals through treatment or destruction. These options, however, are very expensive. Countries with toxic wastes may need to wait until less expensive alternatives are found.

At the very least, the outdated and banned (in the USA) pesticides should be stored under proper conditions until disposal options become available. Such conditions include a well ventilated, dry, shaded, cement-floored facility, with clear labelling of all pesticides.

Chemicals that are still usable should be used on a "first in, first out" basis, i.e., the chemicals that have been in storage the longest should be used first, before those most recently stored, given that the chemicals are still viable and safe to use. Pesticides can be stored in a pesticide bank, such as one centralized place in Europe or possibly at a place designated in West Africa. This minimizes the amount of inventory and oversight needed to control stocks of pesticides.

5. FAO should be requested to establish a system for the inventory of manpower, procedures and equipment.

USAID/The Gambia and USAID/Washington support this recommendation. An inventory of the equipment possessed by APMU is included in Appendix G. Types of equipment inventoried should include: vehicles and exhaust nozzle sprayers, backpack or knapsack sprayers, camping equipment, radios, pumps, safety equipment, batteries, airplane spray equipment, and spare parts.

FAO needs to take the lead on requesting more precise information on equipment and manpower inventories, since they are the donor coordinating agency. They need to be able to provide this information to donors, so that needs can be determined sensibly.

MITIGATION OF NON-TARGET PESTICIDE EFFECTS

6. There should be no pesticide applications in environmentally fragile areas and in human settlements.

Pesticides should only be donated to The Gambia with the understanding that pesticides cannot be used in certain areas, such as designated wetlands, national parks, national forests, and other fragile areas.

7. Pesticides should be those with the minimum impact on non-target species.

Pesticide recommendations in the PEA and USAID's Pest and Pesticide Management Guidelines should be followed until research indicates that safer pesticides are available. USAID/Gambia is strongly encouraged to investigate traditional and cultural locust control methods. This SEA contains a list of approved pesticides in Appendix F.

The Gambian Ministry of Agriculture and APMU may, in the future, be encouraged to use fenitrothion for locust control. While fenitrothion is one of the pesticides approved for locust control in the PEA and in Appendix F, fenitrothion is not used for grasshopper control in the U.S. because other, safer pesticide options exist. Fenitrothion is highly toxic to birds and aquatic invertebrates, and moderately toxic to fish. Therefore, this SEA recommends that acephate, carbaryl, or malathion be used in preference to fenitrothion for locust control near aquatic habitats, and near large concentrations of birds in The Gambia.

8. Pre- and post-treatment monitoring and sampling of sentinel organisms, water, and soils should be carried out as an integral part of each control campaign.

This recommendation should be implemented to the extent that it is possible in The Gambia. The expense of sampling will make it difficult to implement this recommendation. A program of research monitoring is important both as a basis for design of operational monitoring and as a means of establishing statistically verifiable baseline data. In addition, periodic sampling of target and non-target mortality, population numbers, and behavior should be made at locations where pesticides are used. Research results from the LOCUSTOX project in Senegal

should be readily transferable to The Gambia, where environmental conditions and natural resources are similar. USAID/Gambia should request copies of research results from the LOCUSTOX Project. In addition, similar research has been carried out on a smaller scale in Morocco. The results of this research should also be provided to the Gambian APMU.

APPLICATION OF INSECTICIDES

9. The minimum area should be sprayed.

To minimize the area to be sprayed:

1) Emphasis should be placed on an early and vigorous surveillance program. This allows early treatment applications on the earliest instar possible and can reduce the amount of pesticide used.

2) Establish economic thresholds.

3) Identify non-treatment areas such national parks and minimum treatment areas such as game preserves and migratory bird concentrations.

4) Training of decision makers should emphasize restraint in pesticide use.

5) Include farmers and village brigades in pesticide training, survey, and application.

6) Better targeting of aerial operations to allow more precise spraying.

7) A better strategic control program to monitor locust breeding areas, and use appropriate controls to prevent their buildup to a gregarious phase.

10. Helicopters should be used primarily for survey to support ground and air control units.

In the flat lowlands of The Gambia, airplanes are sufficient for surveying and spraying, all of the country is accessible by land, and helicopters should not be used.

11. Whenever possible, small planes should be favored over medium to large two- or four-engine transport types (for application of pesticides). In all cases, experienced contractors will be used.

This SEA supports this recommendation. In The Gambia, small fixed-wing aircraft should be used in the 1993 campaign, if locusts arrive from Senegal in large enough numbers.

12. Any USG-funded locust control actions which provide pesticides and other commodities, or aerial or ground application services, should include technical assistance and environmental assessment expertise as an integral component of the assistance package.

This SEA agrees with this recommendation. Training should be a part of USAID assistance.

13. All pesticide containers should be appropriately labeled.

This SEA agrees with this recommendation and urges the Gambian government to give high priority to pesticide legislation and implementation of pesticide labelling.

DISPOSAL OF PESTICIDES

14. USAID should provide assistance to host governments in disposing of empty pesticide containers and pesticides that are obsolete or no longer useable for the purpose intended.

USAID Washington and FAO have developed guidelines on disposal programs for unwanted pesticides and empty containers. Several pilot disposal projects have been implemented by USAID and other donors. USAID/Gambia should explore disposal options as needed, and should continue to assist with pesticide management to minimize the problem. Disposing of empty pesticide barrels properly is especially important.

PUBLIC HEALTH AWARENESS

15. USAID should support the design, reproduction, and presentation of public education materials on pesticide safety.

USAID and the Gambian Ministry of Agriculture should develop public and applicator education materials on pesticide safety, pesticide poisoning recognition, avoidance, and treatment. In addition, they should take advantage of the large amount of materials produced through the AELGA Project during the past 4 years, while locusts were in recession. These materials could be used in "Train the Trainer" programs, and in village brigade training courses. Many of the materials already prepared for West African countries should be readily transferable to The Gambia.

16. Training courses should be designed and developed for health personnel in areas where pesticides are used frequently.

This SEA supports this recommendation and advocates intergovernmental collaboration in training programs.

17. Each health center should be provided with posters describing diagnosis and treatment of pesticide poisonings, as well as medicines and antidotes required for treatment of poisoning cases.

This SEA supports this recommendation. Posters in The Gambia should be written in the local language(s). It is not known if such posters currently exist in health centers in the Gambia.

18. Presently available tests for monitoring human exposure to pesticides should be implemented in the field.

This SEA supports the need to monitor the health of pesticide applicators and handlers during control operations. This was done during the 1986-1989 outbreaks of grasshoppers and locusts, but is not currently implemented. Any assistance to The Gambia for locust and grasshopper control should include the donation of acetylcholinesterase testing kits, with instructions on their use and followup by USAID and other donors.

PESTICIDE FORMULATION AND MANAGEMENT

19. Specifications for USAID purchase of locust insecticides should be adapted for all insecticides.

The PEA made this recommendation a high priority to be implemented as soon as resources can be allocated. USAID's Pest Management Guidelines will help in the implementation of this recommendation.

20. Pesticide container specifications should be developed.

The PEA made this recommendation, and this SEA supports it. The Agency Pest Management Guidelines will help in the implementation of this recommendation. USAID has had a representative on the EPA's Pesticide Disposal Workgroup, and any changes in EPA's container regulations that are relevant to USAID will be incorporated into USAID policy. Recent attention has focused on the use of smaller, easier-to-handle barrels than the usual 50 gallon drums, although the smaller containers are easier targets for casual thieves.

BIOLOGICAL CONTROL

21. Beauvaria and other biological control agents such as plant extracts should be field tested under African and Asian conditions in priority countries.

USAID/W is currently supporting research on biological control in Africa. USAID/Gambia should promote and support local research on parasites, pathogens, and predators of locusts and grasshoppers.

TRAINING

22. A comprehensive training program should be developed for USAID Mission personnel who have responsibility for control operations.

There are two people at USAID/Gambia that have oversight responsibility for pest control operations, and a short term training course on locust/grasshopper biology, ecology, and control should be presented to them.

23. Local programs of training should be instituted for pesticide storage, management, environmental monitoring and public health (see Recommendation 16).

This SEA supports this recommendation, and further recommends that high priority be given to teaching Gambians how to use pesticides safely and appropriately, especially in village brigade programs.

24. When technical assistance teams are provided, they should be given short-term intensive technical training (including language if necessary) and some background in the use and availability of training aids.

The AELGA Project has been very successful in fielding well-briefed and prepared short-term technical assistance, who were fully aware of the training aids available and their use. In addition, most technical assistance provided has been fluent in local languages, so language training was not needed.

ECONOMICS

25. Field research should be carried out to generate badly needed economic data on a country-by-country by basis.

This SEA supports this recommendation. Agricultural productivity analyses, combined with analyses of the losses sustained from locusts should be pursued by the agricultural economists in the Gambian MOA. Comparisons should be made among several options for control including the cost of not controlling and the costs of preventive and proactive controls versus emergency controls.

26. No pesticides should be applied unless the provisional economic threshold of locusts is exceeded.

Research should be conducted in The Gambia to establish economic thresholds for the desert locust and grasshoppers. Currently, no thresholds have been determined for locust damage. Work has been done on thresholds for other pests, including grasshoppers. The transfer of these findings to locust will take several years, due to all of the variables that will need to be taken into account, including crop type and phenology, and others.

27. USAID should provide assistance to host countries in drawing up regulations on registration and management of pesticides and in drafting environmental policy.

This SEA supports this recommendation. USAID/W and EPA have developed a program to assist countries with drafting pesticide regulations and policies.

PESTICIDE USE POLICY

28. A pesticide use inventory covering all treatments in both agricultural and health programs should be developed, on a country-by-country basis.

This SEA supports this recommendation. The Gambian Ministry of Agriculture and any future regional locust/grasshopper control organization should keep an up-to-date, accurate inventory of all of their pesticides. This inventory should be made available to any donor agency upon request.

PESTICIDE HANDBOOK

29. USAID should produce a regularly updated pesticide handbook for use by its staff.

USAID/W has produced two such handbooks, which are regularly updated: *Pesticide Handler's Guidebook* and the *Pest Management Guidelines of the Agency for International Development*. This SEA supports the continued updating of these handbooks.

SUPPORT AND TRAINING

30. Technical assistance, education and training, and equipment should be provided to crop protection services of host countries with a view to making the services eventually self-sustaining.

This SEA supports this recommendation, but the actual needs of the Gambian Ministry of Agriculture should be thoroughly assessed by USAID before providing assistance. USAID should support and encourage changes that promote the efficient use of donated equipment.

"Train the Trainer" programs for village brigades are a

valuable contribution that USAID/FHA/OFDA has made in The Gambia during the past (1986-89) campaign. The current village brigade program in The Gambia should be evaluated by USAID.

STORAGE

31. More pesticide storage facilities should be built. Until that occurs, emergency supplies should be stored in the United States.

The Gambia currently has at least four properly constructed pesticide storage facilities strategically located throughout the country, and several other base stations where pesticides are stored outdoors in fenced-off areas. A pesticide bank should be established and run by the United Nations, the EEC or another international organization to reduce the need for on-site storage and disposal of locust and grasshopper pesticides.

FORECASTING

32. USAID should make the decision whether to continue funding forecasting and remote sensing or to use FAO's early warning program.

This SEA is in favor of continuing and improving forecasting as an FAO activity. USAID should support thorough field research programs for studying the ecology of outbreaks in East Africa and the Arabian Peninsula, so that plagues can be predicted with greater accuracy.

PUBLIC HEALTH MONITORING AND STUDY

33. A series of epidemiological case-control studies, within the countries involved in locust control, should be implemented in areas of heavy human exposure to pesticides.

While this is an appropriate activity for APMU and/or NEA through their new pesticide legislation, the organization may need an infusion of necessary funds. If the GOTG cannot carry out this activity, FAO or a future regional control organization should. The World Health Organization, in coordination with the Ministry of Health, may be able to provide some support to this effort.

RESEARCH

34. Applied research should be carried out on the efficacy of various pesticides and insect growth retardants, as well as pesticide application.

The main function of the APMU is currently pest control, not research. An international locust research facility is needed. Research should focus on the following areas:

1) Improved aerial spraying. Coverage and drift are major problems.

2) Identify pathogens and parasites of locusts for each stage of the locust life cycle and develop systems to deliver and apply these natural enemies. By targeting each stage of the locust life cycle, it is unlikely that sufficient numbers of locusts could reach adulthood for swarms to develop. When a pesticide is sprayed it serves only to kill locusts at that particular place and time. A pathogen would have the advantage of spreading and multiplying to kill future generations of locusts.

3) Determine the conditions which cause solitary grasshoppers to become gregarious and swarm. Determine the physiological response of grasshoppers to those conditions. Finally, investigate ways to interfere with that response (e.g., through applications of synthetic hormones).

4) Develop safer pesticides. This would include "pesticide cocktails" that mix pyrethroids (or other chemicals) with organophosphates to promote rapid knockdown.

5) Find a safe, biodegradable dye or odorous compound (for ULV formulations) to mix with the insecticides, so that it would be obvious to farmers, shepherds, and nomads which plants and locusts are sprayed. A colored pesticide would also aid pesticide applicators evaluate the effectiveness of coverage and existence of contamination. Ideally the dye or odorous compound should be added at the factory that is producing the insecticides so that leaks and contamination would be obvious throughout operations. The dye or odorous

compound must not interfere with the efficacy of the pesticide.

35. Applied research should be carried out on the use of plant extracts as anti-feedants.

Small scale laboratory and field studies should be used to determine which botanical extracts are the most promising anti-feedants and repellents. A common error in research on repellents is to give the insect a choice of treated versus untreated food. If insects are seen to prefer the untreated food the repellent is declared effective. However, under field conditions, where an entire crop is treated, the insects may choose to consume the treated crop instead of starving. This is one of the reasons that neem tree extracts are so effective in laboratory choice tests, but frequently ineffective in field trials.

In 1993 the AELGA Technical Advisor discovered a tree in Eritrea on which the desert locust would not feed; further questioning led to the discovery that the tree was a variety of sesame. This discovery will be followed up on and extracts from these sesame trees will be tested for feeding repellency and toxicity to locusts. This is an excellent example of pioneering progress on the search for anti-feedant extracts being pursued by USAID and the AELGA Project.

36. Research should be carried out to determine the best techniques for assessing the environmental impact of organophosphates used for locust control.

Some of this research has been undertaken already and more is underway. The USAID Africa Bureau AELGA Project funded research through the Dynamac Corporation in 1987. The study was able to show that most of the chemicals being used break down rapidly in the environment to levels well below those required the US EPA.

In 1989 FAO began a multi-donor pilot ecotoxicological study of locust control pesticides in Senegal. The first year's results were successful in identifying deleterious effects of some pesticides on birds, aquatic life, beneficial and non-target arthropods, and soil microbial processes; as well they learned the amount of time needed for species and environmental recovery to occur. FAO followed up with a project named LOCUSTOX to

screen more insecticides, test other factors such as area treated, develop methodologies relevant to Africa, and train local scientists in their use. Other donors and groups are expanding similar research into Chad, Mali, Mauritania, Morocco, and Niger. In fact, USAID funded a study on the effects of pesticides on sentinel organisms in Morocco.

ENHANCING AND ACCELERATING IMPLEMENTATION

37. USAID/W should provide guidance in locust control to missions in the field.

The AELGA Project has already provided technical assistance, situation reports, and guidance to field missions on appropriate actions to take in dealing with outbreaks. AELGA rapidly fielded technical assistance to complete this SEA in 1993. Guidance to The Gambia will likely include a program for training village brigades, and will encourage the following agricultural practices:

1) Develop irrigation systems if possible so that crops are not entirely dependent on local rainfall. Growing crops in accordance with local rainfall insures that locust and crops will be in synchrony.

2) Nomadic farmers that shift agricultural sites should be encouraged to remove weeds from their fields.

3) After harvest, nomads should burn their old fields to destroy weeds and any remaining crops which could serve as locust habitat.

4) Locating and digging up egg fields.

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

This SEA supports this recommendation. The guidelines should include information on forming and training village brigades.

International cooperation must continue and should be strengthened. Suggestions that each country should only be concerned with their own locust problems are short-sighted. Nations that host breeding areas should not be expected to bear the entire burden of plague prevention. It is in the best interest of all nations effected by plagues to pool their resources in the campaign against locusts as an insurance policy. It is also in the best interest of donor agencies to coordinate their efforts so that assistance is used as effectively as possible.

If there is evidence of poor management or mismanagement of a future regional Sahelian locust/grasshopper control organization, donors should not hesitate to withhold funding. The director and staff of such an organization should be held accountable by FAO and other donors for the management and condition of the facilities, including:

1) Locust survey and control
2) Keeping well-organized, accurate, accessible records of all locust survey and control operations
3) Keeping well-organized, accurate, accessible records of inventory of pesticides, pesticide application equipment, and pesticide safety equipment
3) Research
4) Pesticide storage
5) Pesticide disposal
6) Pesticide drum disposal
7) Maintenance and proper use of equipment
8) Following all safety procedures for pesticide handling and application

APPENDIX C. RELEVANT DOCUMENTATION

FAO Pesticide Management Documents:

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

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

c) Guidelines for pesticide disposal and container disposal.

d) List of FAO approved pesticides.

e) Pesticide storage and packaging guidelines.

f) Guidelines for pesticide approval and management.

g) Ecotoxicological guidelines.

h) Ground and aerial application guidelines.

i) Insecticide poisoning: prevention, diagnosis, and treatment.

j) Guidelines for effective labeling.

k) Efficacy requirements for pesticide approval.

Other Documents on Pesticides and Locust Control

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

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

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

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

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

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

USEPA Pesticide Fact Sheets:

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

These are some of the many Pesticide Fact Sheets issued by the U.S. Environmental Protection Agency, selected for relevance to locust control. The Pesticide Fact Sheets summarize data, including information on acute and chronic toxicity to humans and other non-target organisms, handling precautions, and instructions for use. They are available from:

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

APPENDIX D. USAID APPROVED PESTICIDES

(Copy of 1993 cable State 118760)

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CLEAR: { }

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CLEAR: { }

CLEAR: { }

AID/AFR/ONI/TPPI:YBELAYNEH:YB
04/08/93 {703} 235-5411
AID/AFR/ONI/TPPI:ZHAHN

AID/AFR/ONI/TPPI:VDREYER{DRAFT}
AID/NE:GJACKSON{DRAFT}
AID/AFR/ARTS:JGAUDET{DRAFT}
AID/GC/AFR:ESPRIGGS{DRAFT}
AID/AFR/ONI/TPPI:ASHOWLER{DRAFT}
AID/POL:JHESTER{DRAFT}
AID/AFR/FHA/OFDA:GHUDEN{DRAFT}
AID/ASIA/DR/TR:MKUX{DRAFT}

ROUTINE AIDAF

AIDAC NAIROBI FOR REDSO/ESA; ABIDJAN FOR REDSO/WCA;
NE/ENA

E.O. 12356: N/A

TAGS:

SUBJECT: UPDATE ON A.I.D.-APPROVED LIST OF PESTICIDES FOR
LOCUST/GRASSHOPPER CONTROL

1. SUMMARY: AID/AFR/ONI IS IN THE PROCESS OF REFINING THE LIST OF PREFERRED PESTICIDES PRESENTED IN THE 1989 PROGRAMMATIC ENVIRONMENTAL ASSESSMENT {PEA} FOR LOCUST AND GRASSHOPPER CONTROL IN AFRICA AND ASIA. THE INFORMATION IN THIS CABLE UPDATES SIMILAR TABULAR DATA IN THE PEA, AND SUPERCEDES SIMILAR DATA IN A.I.D.'S 'REVIEW OF ENVIRONMENTAL CONCERNS IN A.I.D. PROGRAMS FOR LOCUST AND GRASSHOPPER CONTROL, PUBL. SERIES NO. 91-7'. THE INFORMATION ON PESTICIDES IN THIS CABLE SHOULD BE CONSIDERED TO BE AN AMENDMENT TO THE PEA. THE TABLE LISTING PESTICIDES IN THE ENVIRONMENTAL CONCERNS DOCUMENT WAS ONLY MEANT TO INDICATE PESTICIDES THAT CAN BE PURCHASED WITH A.I.D. FUNDS, BUT IT SHOULD NOT BE CONSIDERED AS GUIDANCE FOR PESTICIDE SELECTION, END SUMMARY.

2. WITH MORE AND MORE INFORMATION ON PESTICIDES BEING GENERATED, AID/AFR FINDS IT NECESSARY TO REFINE ITS LIST OF A.I.D.-APPROVED ANTI-LOCUST/GRASSHOPPER PESTICIDES.

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THE FOLLOWING IS AN ALPHABETICAL LISTING OF THE PESTICIDES APPROVED IN THE PEA. THE LIST INCLUDES RELEVANT INFORMATION ON TOXICITY, BIO-ACCUMULATION AND SIGNAL WORDS (TO INDICATE THE RELATIVE TOXICITY OF EACH INSECTICIDE). THIS INFORMATION PROVIDES A SKETCH OF PROPERTIES OF THE A.I.D.-APPROVED ANTI-LOCUST/GRASSHOPPER PESTICIDES. ALL OF THE CHEMICALS LISTED BELOW ARE CURRENTLY REGISTERED EITHER BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) OR ITS EQUIVALENT IN OTHER COUNTRIES FOR LOCUST AND GRASSHOPPER CONTROL.

	TOXICITY TO						
	FISH	INVER	BIRD	MAMML	BIOAC	PERS	SIGNW
1. ACEPHATE	L	L	L	M	L	L	C
2. BENDIOCARB	M	M	M	M	M	M	W
3. CARBARYL	L	L	L	L	L-M	L	C
4. CHLORPYRIFOS	M	H	M	M	M	L	C-W
5. DIAZINON	M	H	M-H	L	M	M	C-W
6. FENITROTHION	L	H	H	L	M	L	W
7. LAMBDA-CYHALOTHRIN	H	H	L	H	H	M	D
8. MALATHION	L	L	M	L-M	L	L	C
9. TRALOMETHRIN	H	H	L	L	H	M	D

LEGEND:

NON-TARGET ORGANISMS: FISH, INVERTEBRATES (INCLUDING HONEYBEES), BIRDS, MAMMALS

BIOAC = BIO-ACCUMULATION, PERS = PERSISTENCE,

L = LOW; M = MODERATE; H = HIGH (APPLY TO TOXICITY LEVELS TO NON-TARGET ORGANISMS, BIO-ACCUMULATION AND PERSISTENCE; RELATIVE TOXICITY IS ALSO A FUNCTION OF FORMULATION AND ACTIVE INGREDIENT CONCENTRATION)

SIGNW = SIGNAL WORD: C = CAUTION; W = WARNING; D = DANGER (POISON); (APPLIES TO THE RELATIVE TOXICITY OF PESTICIDES IN ASCENDING ORDER; RELATIVE TOXICITY IS ALSO A FUNCTION OF FORMULATION AND ACTIVE INGREDIENT CONCENTRATION)

SPECIFIC DOSAGES MUST BE WORKED OUT BY HIGHLY EXPERIENCED PERSONNEL FAMILIAR WITH THE APPLICATION EQUIPMENT, PESTICIDE FORMULATION, ETC., TO BE USED. FOR ELABORATION ON THE PROPERTIES OF A.I.D.-APPROVED ANTI-LOCUST/

GRASSHOPPER PESTICIDES, CONSULT THE PEA AND COUNTRY-SPECIFIC SUPPLEMENTARY ENVIRONMENTAL ASSESSMENTS (SEAS).

3. IT IS IMPORTANT THAT ALL PRECAUTIONS INDICATED ON THE PESTICIDE LABELS, E.G., APPLICATION DOSAGES, SAFETY MEASURES, INSTRUCTIONS ON HANDLING AND STORAGE PROCEDURES, DISPOSAL OPTIONS, ENTRY BY UNPROTECTED PERSONS INTO TREATED AREAS, EMERGENCY GUIDELINES, ETC., BE CAREFULLY OBSERVED, AS OUTLINED IN THE COUNTRY-SPECIFIC SEAS.

4. AID/W WILL KEEP MISSIONS INFORMED OF FUTURE UPDATES ON THE LIST OF A.I.D.-APPROVED ANTI-LOCUST/GRASSHOPPER PESTICIDES. YY

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ADDITIONAL CLEARANCES:

AID/AFR/EA:PGUEDET(INFO)
AID/AFR/CCWA:MGOLDEN(INFO)
AID/AFR/SWA:JGILMORE(INFO)
AID/AFR/SA:KBROWN(INFO)
AID/AFR/ARTS/FARA:WKNAUSENBERGER(DRAFT)
AID/RD/AGI:RHEDLUND(INFO)

APPENDIX E. QUANTITIES AND CONDITION OF EQUIPMENT HELD BY APMU IN THE GAMBIA

1994 DESERT LOCUST CAMPAIGN
MINISTRY OF AGRICULTURE - THE GAMBIA
NATIONAL REQUIREMENTS

ITEM	DESCRIPTION	QUANTITY	AVAILABLE NATIONAL STOCK	ADDITIONAL NEEDS	REMARKS
1.	PESTICIDES				
	I Chloropyriphos 480 ULV	20,000 L	0.0 L	20,000 L	Aircraft use
	ii Fenitrothion 96% ULV	20,000 L	0.0 L	20,000 L	Aircraft use
	iii Sumicombi 60 EC	10,000 L	4044	5956	Groundteams
	iv Chloropyriphos 5 D	100 tons	0.0 tons	100 tons	Farmer Brigades
	v Sumicidin 20 EC	10,000 L	2980	7020	Groundteams
2.	EQUIPMENTS				
	i Motorised sprayers	400	0	400	Groundteams
	ii Knapsack sprayers	2000	230	1770	Groundteams
	iii Knapsack duster	8000	200	7800	Farmer Brigades
	iv Sac dusters	60,000	500	59500	Farmer Brigades
	v Vehicle mounted sprayers	8	4	4	Groundteams
3.	PROTECTIVE CLOTHING				
	i Overalls	1000	49	951	Groundteams
	ii Mask & Cartridges	2000	100	1900	Groundteams
	iii Goggles	2000	100	1900	Groundteams
	iv Gloves	1000	0	1000	Groundteams
	v Boots	1000	100	900	Groundteams
	vi Helmets	1000	0.0	1000	Groundteams
	vii Dust mask	60,000	0.0	60,000	Farmer Brigades

FIRST AID				
i First Aid Kits	20	0	20	Groundteams, Farmer
ii Cholinesterase Kits	8	0	8	Brigades and Pilots
iii Antidotes				Brigades and Pilots
a) Charcoal Biscuits	100kg	–	100kg	Groundteams
b) 2-PAM	1000 Ampules	–	1000 Ampules	Farmers and Pilots
c) Atropine sulphate	500 Ampules	–	500 Ampules	" " "
VEHICLES				
i Station Wagons	3	0		
ii Pickups	8	2	6	Groundteams
iii Motorcycles	30	10	20	Pilots and logistics
iv Trucks (5 tonners)	4	1	3	
RADIO COMMUNICATION				
i Radio set 1Com 135 HF	35	5	30	Groundteams and Pilots
ii Antennae	35	2	32	
iii Generators	35	0	35	
iv Battery charger	35	0	35	
v Batteries	35	0	35	
vi Transformers (22-240 volts)	1	0	1	Reniews Headquarters
AGRICULTURAL AIRCRAFT				
i Twin-Engined	2 (100ft hours	0	2 (100ft hours)	Aerial spraying
ii Tanks	10,000 L	0	10,000 L	For use by cessna planes
iii Fuel	1000 L	0	17,000 L	" " "

OPERATIONAL COST/LOGISTICS				
i Administration	D 300,000			Campaign staff
ii Allowances	D 600,000			Campaign
iii Fuel	D 500,000			
a) Gasoil	10,000 L	0	10,000	Groundteams and Pilots
b) Petrol	10,000 L	0	10,000	and logistics
c) Engine oil	2000 L	0	2000 L	
iv Casual labourers	20	0	20	Logistics
MISCELLANEOUS				
i Pesticide pumps	4	0	4	Stores at Yundum, Jenci Sapu and Airport
ii Aerial spray Flag markers	60	0	60	Aerial spraying

AGENCY FOR INTERNATIONAL DEVELOPMENT
BUREAU FOR AFRICA
Disaster Response Coordination Office
AFR/AA/DRCO

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

FINAL ACTION FORM

COUNTRY: The Gambia

DATE: November 1993

Recommendation:

ACTION TAKEN:

Approved: ✓ Date 1/12/94

Disapproval: _____ Date _____

Bureau Environmental Officer, John Gaudet: John J. Gaudet