PN-ABR-459

AGENCY FOR INTERNATIONAL DEVELOPMENT
POL/CDIE/DI REPORT PROCESSING FORM

ENTER INFORMATION ONLY IF NOT INCLUDED ON COVER OR TITLE PAGE OF DOCUMENT

1. Project / Subproject Number: 698-0517

2. Contract / Grant Number:

3. Publication Date: July 1992

4. Document Title / Translated Title: Supplementary Environmental Assessment of the Madagascar Locust Control Program

5. Author(s)
1. George Cavin
2. Bill Thomas
3.

6. Contributing Organization(s)
- USAID/ Madagascar
- The Government of Madagascar

7. Pagination:

8. Report Number:

9. Sponsoring A.I.D. Office: AFR/ARTS/FARA

10. Abstract (optional - 250 word limit)
Please use the documents Preface (Page III) for the abstract.

11. Subject Keywords (optional)
1.
2.
3.
4.
5.
6.

12. Supplementary Notes

13. Submitting Official: Alise LaRoche

14. Telephone Number: 703-235-5419

15. Today's Date: 5/18/94

DO NOT write below this line

16. DOCID

17. Document Disposition: DOCRD [ ] INV [ ] DUPLICATE [ ]

AIS 590-7 (06/93)

SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT

OF THE MADAGASCAR

LOCUST CONTROL PROGRAM

United States Agency for International Development

Mission to Madagascar

In cooperation with the Government of Madagascar

Antananarivo, Madagascar

July, 1992

TABLE OF CONTENTS

Section	page
List of Tables and Figures	iii
Preface	iv
Acronyms and Abbreviations	v
1.0 EXECUTIVE SUMMARY	1
2.0 PURPOSE AND PROCEDURES	3
2.1 Background	3
2.2 Drafting Procedures	4
2.3 Previous Assessments	4
2.4 Environmental Procedures	5
2.5 Madagascar Environmental Procedures	6
3.0 PROJECT DESCRIPTION	7
3.1 Madagascar Environment Profile	8
3.2 Agricultural Resources	10
3.3 Locusts	13
3.4 Locust Management - Overview	14
3.5 Locust Management - Operations	20
3.6 Pesticide Management	27
3.7 Cultural and Biological Management	32
3.8 Safety and Health Care System	34
3.9 Environmental and Non-Target Impact	38
4.0 PROTECTED AREAS/WILDLIFE	41
4.1 Protected Animals and Plants	42
4.2 Protected Areas	43
4.3 Pesticide Alternatives in Sensitive Areas	47
8.0 REFERENCES	48
APPENDIX A. LIST OF PREPARERS/CONTACTS	50
APPENDIX B. ANALYSIS OF PEA RECOMMENDATIONS	51
APPENDIX C. RELEVANT DOCUMENTATION	63

LIST OF TABLES AND FIGURES

Tables

		page
Table 1.	Crop Production, 1981 to 1989	12
Table 2.	Structure of Agricultural Ministry	21
Table 3.	Protected Areas	45

Figures

Figure 1.	Base map of Madagascar	9
Figure 2.	Map of the Major Crop Growing Regions	11
Figure 3.	Map of protected Areas	46

PREFACE

This document is a supplement to the Programmatic Environmental Assessment (PEA) concerning USAID assistance in Locust control programs. This Supplementary Environmental Assessment (SEA) was prepared by an AID/W (AFR/ARTS/FARA) Technical Assistant, the A.I.D. Mission to Madagascar, with support from the Government of Madagascar (GOM). Document preparers and contact persons are listed in Appendix A.

This document has been reviewed by A.I.D./Madagascar, the Government of Madagascar and AID/W. It reflects the best current description of future options for the USAID assistance programs to the Madagascar Crop Protection Service for locust management. It contains the best available 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. This document is intended to complement and support the multi-donor funded Madagascar National Environmental Action Plan. Encouragement is given for the use of alternatives to chemical pesticides, along with prudent and environmentally sound use of pesticides when these materials are necessary. The commitments for any possible future program are contingent on the future needs for locust control, the capabilities of the Malagasy CPS, and on a decision by A.I.D. to provide assistance.

LIST OF ACRONYMS AND ABBREVIATIONS

AChE	AcetylCholinesterase
AELGA	African Emergency Locust/Grasshopper Assistance Project - USAID/Washington
ALS	Madagascar Anti-Locust Service
APHIS	Animal and Plant Health Inspection Service of USDA
CFR	US Code of Federal Regulations
CPS	Crop Protection Service
EA	Environmental Assessment
EPA	US Environmental Protection Agency
FAO	Food and Agriculture Organization of the United Nations
GOM	Government of Madagascar
ha	hectare
IPM	Integrated Pest Management
km	kilometer
mg/kg	milligram per kilogram (body weight)
PEA	Programmatic Environmental Assessment
ppm	parts per million (ambient concentration)
REDSO	Regional Economic Development Support Office
SEA	Supplementary Environmental Assessment
A.I.D./W	U.S. Agency for International Development, Washington, DC
USAID/Madagascar	- USAID Mission to Madagascar, located in Antananarivo
USDA	U.S. Department of Agriculture

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 Madagascar in order to allow A.I.D. assistance in regard to locust management. The material in this document considers the specific locust and species in Madagascar, and the potential environmental impact of control options. This environmental assessment is an extension of the PEA and is, as such, an integral part of it. Both documents should be consulted during both planning and operational stages of implementation.

The information contained in this document is intended for use by USAID/Madagascar and the Madagascar Crop Protection Service (CPS) to guide environmentally sound locust management. Of the acridian species in Madagascar, only two, the Migratory Locust and the Red Locust, are considered to be significant economic pests. Of these, the Migratory Locust is far more of a widespread threat to agricultural crops, and will likely be the pest requiring control activities. However, the discussions herein need not be limited to these specific pests, provided that consideration is given to the climatic, biological, and environmental diversity of Madagascar. Additional relevant information should be added to this SEA as needed in the form of appendixes, as this is a dynamic, rather than static document.

Due to the extremely fragile and unique ecology of Madagascar, as well as the notable diversity of biological organisms living on the island, this document recommends that any U.S.-funded assistance concerning locust management, in as much as possible, not to promote the use of chemical pesticides. Several viable alternatives exist which can allow for substantial locust control. This sort of assistance will fit well with the already extensive environmental and bio-diversity portfolio of USAID/Madagascar activities. This SEA recommends that FAO take the lead in this area, as this organization has had considerable experience in Africa and Asia with such efforts.

Survey and immediate treatment operations are considered foremost in preventing locust and other pest outbreaks. Prevention is the key to reduce crop loss and pest control operation costs. Early season intervention requires considerable less pesticide than late season emergency operations, and therefore has less impact on the environment.

Environmental awareness is emphasized. The ecological diversity of Madagascar is unique, and therefore merits special attention. Fragile ecological areas need to be protected from chemical pesticides, as the impact can be both dramatic and long lasting. Buffer zones of at least 5 kilometers surrounding

established fragile areas should be observed in any U.S.-funded control operation.

Proper pesticide management must be a priority in control operation programs. Because misused pesticides effect both the environment and crop production in terms of increased costs, any control program must consider possible consequences carefully. Pesticide container disposal must be conducted so as to eliminate food or water storage in used containers. In this regard, supportive legislation and regulations must be enforced to promote sound pesticide management practices. These issues must be fully considered and monitored in a USAID-funded activity.

Training must be part of any USAID assistance program. Pesticide safety and the environmental effects of pesticide use and misuse should be conveyed to both CPS personnel, and the general public through education and public awareness campaigns. Farmer training and Village Brigades can be an important part of management operations, and their use should be stressed.

The Madagascar CPS, with assistance from the Swiss government, is beginning a laboratory analysis program to monitor pesticide formulation quality and environmental residues. This should be supported whenever possible. Analysis of blood acetylcholinesterase testing in pesticide handlers and applicators is recommended, and should be part of a U.S.-funded program.

Monitoring of pesticide effects on non-target species and the environment should be included as an integral part of any pesticide use program. Monitoring results should be used in the planning and operational phases of future locust control programs to adjust or curtail environmentally damaging operations.

The stock of obsolete pesticides in Madagascar includes some 43,000 liters of dieldrin. This pesticide should be appropriately disposed of as soon as possible. Proper disposal of this and other unwanted pesticides is essential. Disposal and/or recycling of empty pesticide containers in Madagascar should be under the jurisdiction of the GOM; since Madagascar has several local pesticide formulation plants, container recycling is highly recommended.

2.0 PURPOSE AND PROCEDURES

2.1 Background

In 1987, due to an outbreak of both grasshoppers and locusts in Sahelian Africa, the Administrator of the U.S. Agency for International Development declared an emergency waiver of the agency's environmental procedures governing the provision of pesticides. The waiver permitted A.I.D. to provide assistance for procurement and use of pesticides for locust/grasshopper control without full compliance with the Agency's environmental procedures. The Administrator's waiver expired on August 15, 1989.

With the expiration of the Administrator's waiver, any future A.I.D. assistance for procurement and use of pesticides must fully comply with the Agency's environmental procedures. In 1989, a Programmatic Environmental Assessment (PEA) was completed. The PEA, and the country-specific Supplemental Environmental Assessments (SEAs) will serve as the basis for these regulatory procedures. The SEAs contain specific environmental information and provide guidance on environmentally sound management procedures for pesticide use in a particular country, and SEAs have already been completed for most of the Sahelian countries.

Given that Madagascar, as with the African continent, will continue to experience periodic locust outbreaks, and cyclic population fluctuations, control campaigns for these and other insects are likely to continue indefinitely. Locusts are part of the ecology of the Madagascar Island system, and will readily take advantage of agricultural crops. Control measures must manage problematic insects at economically reasonable levels in regard to crop loss, rather than try to achieve extermination. The goal of any U.S.-funded assistance to locust management should be the sustainability of the Madagascar Crop Protection Service operations.

Because of the both periodic and cyclic fluctuations of locusts, and their potential impact upon food supplies, it is likely that requests for A.I.D. technical assistance, aerial application services, commodities, equipment and/or insecticides will continue. While it is likely that many of these requests will be related to the use of chemicals for control operations, it is important that A.I.D. take the lead in investigating and providing alternative chemicals which have a potential negative environmental impact. This is especially important considering the fragile and unique ecology of Madagascar. Should USAID/Madagascar choose to provide chemical pesticides, the Environmental Procedures in Regulation 16 (22 CFR 216) must be followed. Along with the PEA, this document fulfills the requirements necessary to allow A.I.D. to provide assistance to Madagascar.

2.2 Drafting Procedure

A.I.D. Environmental Procedures (22 CFR 216.3(a)(4), describes the process to be used in preparing an Environmental Assessment. The rationale and approach for the country-specific Supplemental Environmental Assessment [SEA] are outlined in cables 89 State 258416 (12 Aug. 1989) and 89 State 275775 (28 Aug. 1989).

This draft Supplemental Environmental Assessment (SEA) for the country of Madagascar was produced in July of 1992 by AID/W (AFR/ARTS/FARA) Technical Advisor Bill Thomas with assistance from George Cavin and personnel of the USAID/Madagascar Mission. The USAID/Madagascar Agricultural Development Office (ADO) and the Health Office (HPN) assisted in the preparation of this draft by providing logistical support for needed field work, reference documentation, and contacts within the Madagascar government.

Two field trips were undertaken as part of the preparation of this document. A ground-based trip to the western areas around Tsiroanomandidy, and an air trip to the western and southern regions. Both trips impressed the drafter as the vastness and ruggedness of Madagascar, and the extreme logistical difficulties which will be encountered in mounting a locust campaign. In addition, the ecological uniqueness and fragility of the biological organisms became clear upon visiting the forest areas east of Ambovombe. The considerable extent of erosion and deforestation was extremely clear from the air over the western and central areas. Despite the difficulties to be encountered during a locust control operation, environmental protection must be considered a priority.

2.3. Previous Assessments

The previous assessment concerning this subject, and the primary supportive document is the Programmatic Environmental Assessment for Locust and Grasshopper Control in Africa/Asia (TAMS/CICP, 1989) (PEA). The PEA covers grasshopper and locust control operations in Africa and the Near East. 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 addressed in the PEA.

Other assessments in regard to the locust include:

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

(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 the Sahelian countries of Chad, Cameroon, Burkina Faso, Mali, Mauritania, Niger, and Senegal.

These documents have been used freely in the preparation of this assessment and are often relied on without citation. Internal USAID/Madagascar data are used without citation. Other relevant documents are cited in the text when supportive data is used.

In addition to the above locust-specific documents, there are numerous documents which concentrate on the environmental, ecological, and biological characteristics of Madagascar. Of particular interest are the Government of Madagascar Environmental Action Plan, and the IUNC Conservation Monitoring Centres' Madagascar: An Environmental Profile. These documents are fully cited in the reference section 8.0, and should be consulted for further information.

2.4. Environmental Procedures.

It is A.I.D. policy to ensure that any negative environmental consequences of an A.I.D.-financed activity can 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 pesticide use are highly recommended when appropriate, and considered to be part of an overall integrated pest management (IPM) program.

Although Madagascar does not have procedures equivalent to the U.S. National Environmental Policy Act (NEPA) or A.I.D. Environmental Procedures, it does have some regulations governing the substance of such programs. These are covered in the following section. Procedurally, A.I.D. Environmental Regulations and Procedures will be controlling for the present because they are more comprehensive and more applicable to A.I.D. programs and projects.

2.5 Madagascar Environmental Procedures

2.5.1. Madagascar Pesticide Regulations

To facilitate the proper and safe use of pesticides, regulations and enforcement are necessary. These regulations cover the importation of pesticides, the distribution to agricultural areas, the actual use of the pesticide, and the disposal of unwanted pesticide and used containers. These laws mandate governmental authorization prior to the importation of pesticides.

While Madagascar has some pesticide control regulations, these are considered inadequate, and are only sporadicly enforced. Malagasy laws require the granting of pre-import clearance prior to pesticide import, with the Ministry of Trade issuing permits for importation. Additional donor assistance in this area is needed. This SEA recommends that FAO take the lead in this area, as this organization has had considerable experience in Africa and Asia with such efforts.

A U.S. pesticide contribution to Madagascar, or a U.S.-funded pesticide purchase in Madagascar will be controlled not only by applicable Malagasy laws and regulations, but also by U.S. pesticide regulations and procedures, as described in the PEA. In this regard, only those pesticides listed in the PEA, or amendments thereof, are acceptable, unless this SEA is amended to cover possible environmental impact which may result from the use of that particular pesticide. Pesticides used in a U.S. operation 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 United States. This especially includes the chlorinated-hydrocarbons, such as dieldrin and lindane.

2.5.2. Other Environmental Regulations in Madagascar.

Environmental and Natural Resource legislation is covered fully by the Rapport National pour Madagascar (Randrianarijaona and Razafimvelo - 1983) and should be consulted for details not included in this section.

Species legislation is based primarily on the 1933 London Convention and on Ordonnance No. 60-126 of 03.10.60. The fauna is divided into three categories: protected, game, and vermin. The protected species are covered by a series of codes which control hunting and fishing. In addition, legislation exists to protect critical habitat and regulate potential exploitation in

those areas. Some species can be utilized commercially under "exceptional" circumstances (61-093) and others can be utilized for scientific research (71-006).

Any USAID/Madagascar-funded programs involving pesticide use for the control of locusts should follow applicable Malagasy regulations concerning the protection of designated areas. In that regard, this SEA supports the GOM commitment to protect the natural environment, and adopts any GOM mandated conditions limiting the use of pesticides, and also follows the designated zones that are protected from pesticide use.

3.0 PROJECT DESCRIPTION

Madagascar has experienced intermittent Migratory Locust infestations and chronic problems over the past several decades. Because the island has widely fluctuating temperatures, rainfall, and ecological zones, Madagascar can suffer from serious locust outbreaks. Insect infestations are compounded when productivity is lowered by other conditions such as drought, plant disease or other pest damage. Madagascar will continue to experience future problems from the Migratory and Red Locust. While the level at which such problems may occur is difficult to predict, especially in regard to seasonal migrations and dispersions in the island system, major outbreaks can be prevented by a vigorous survey and early treatment program.

Since locust populations fluctuate by nature, the intensity and location of future outbreaks are uncertain. While it is likely that the majority of control interventions for the Migratory Locust will take place in the southern regions, this may not necessarily be the case during a major outbreak. Therefore, this assessment does not focus on any specific level of intervention. Instead, it assumes a spectrum of possible interventions, from minor interventions by individual farmers to the possibility of A.I.D. assistance when the magnitude of the problem is too great for the Madagascar Anti-Locust Service (ALS).

Whatever the level of infestation, active coordination between USAID, other donors, and participating organizations is essential. Support for ALS programs involving training, control operations, management planning, survey, and early season intervention should be emphasized. Considerably less emphasis is placed on late season emergency operations which may involve large-scale aerial pesticide spraying. Because early season control operations can prevent late season emergency operations which will likely involve significant amounts of pesticides,

preventive oriented operations are less expensive in terms of environmental impact and operational costs.

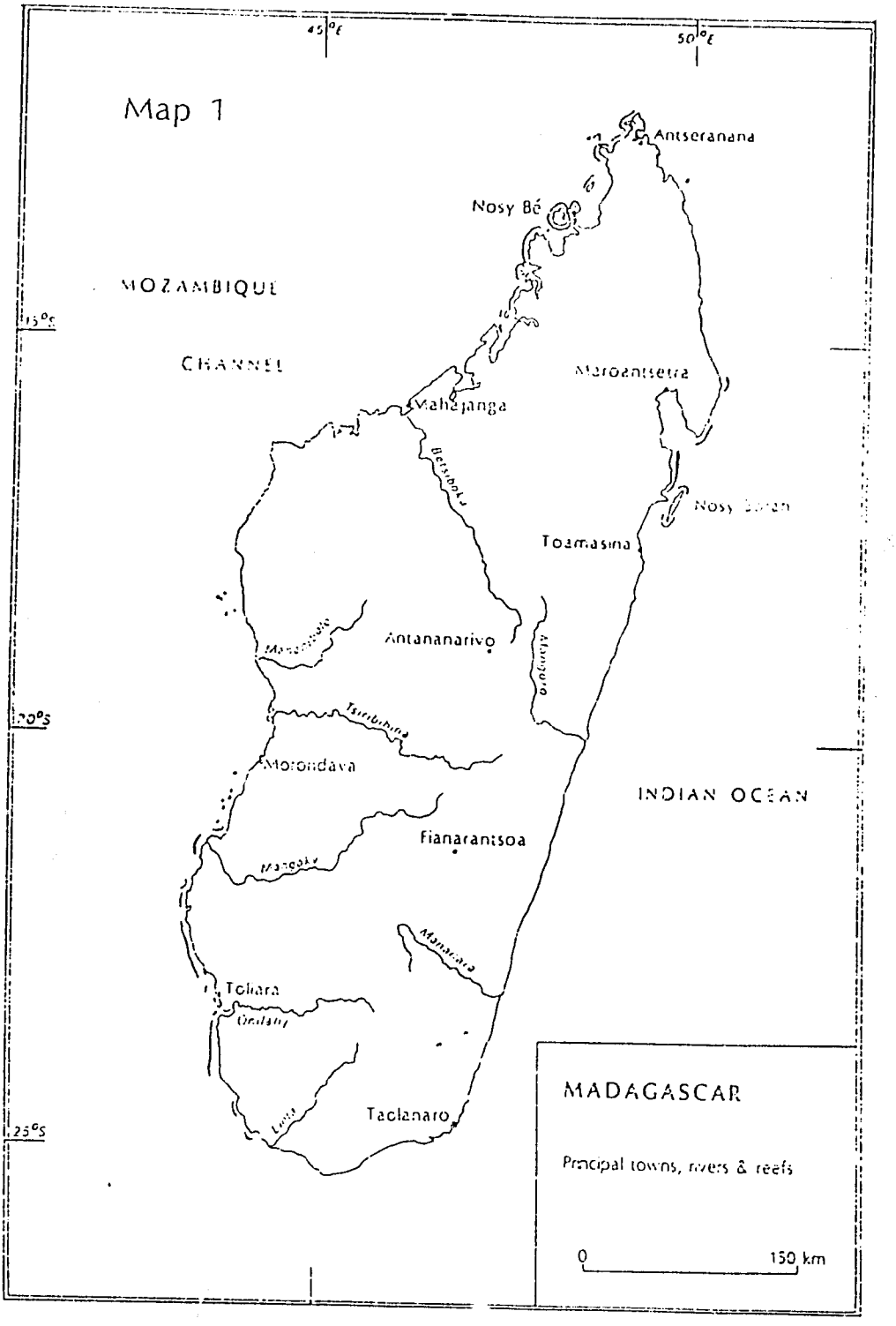
3.1 Madagascar - Environmental Profile

Madagascar is an island with an area of 587,000 km2 (227,000 sq.miles) located in the southern Indian Ocean, about 400 km from the southern coast of Africa (Figure 1). It is the fourth largest island in the world, covering some 1,600 km between latitudes 12 and 25 south. Madagascar topography is extremely varied, ranging from rugged hills and mountains to dense tropical forests, with great diversity in plants and animals. A mountain chain extends nearly the length of the island, creating a central highlands region with an average altitude of 1000 meters. The eastern coastal region contain the country's remaining forests, with rolling savannas in the middle west, and delta plains and baobab forests on the west coast. The south is a semi-desert with thorny vegetation, seasonal rivers, and rocky formations.

Precipitation normally occurs during the months of November to April,and is characteristically variable with respect to amounts (3000 mm in the north, 1500 mm in the western and central regions, 2000 mm in the eastern coastal areas, 600 mm in the south) and distribution (localized and erratic). Area rainfall is a result of the interaction of south-east ocean trade winds produced by the Indian Ocean anticyclone. During the summer months (November - April), the intertropical convergence zone (ITCZ) brings moisture-laden air, with primary intensity in the northern areas of the island, and least in the south. Yearly average temperatures range between 3 and 27 degrees C, with the northern regions cooler than the south. Altitude has a significant effect on temperature, with a change of 0.6 C for every 100 m change.

With the exception of the soils found in river valleys and estuaries, which receive annual deposits of alluvium, the soils of Madagascar are generally tropical in nature, and subject to considerable erosion. The soils of the forest and savanna areas are composed of lateritic clays, and have virtually no surface humus. Although these are considered to be poor soils, they are not altogether infertile. The western valleys contain black soils rich in humus, with alluvial plains in the western deltas. Deforestation has contributed to erosion, and will likely continue to contribute to decreased fertility overall. Without careful forest management, as well as crop rotation in the agricultural areas, soils can structurally deteriorate, resulting in a loss of water and nutrient holding capacity. In the higher rainfall regions, soils are subject to sheet erosion caused by rain, and to mineralization of humus.

Figure 1. Base Map of Madagascar



Madagascar is considered to be a sparsely populated country, with some 11 million inhabitants and a growth rate of 3 percent a year. Over 75 percent live in rural areas, with the highest population densities in the central highlands. Nearly 85 percent of the population is engaged in the agricultural sector, with most farmers growing rice - the staple food crop.

3.2 Agricultural Resources

The major agronomic food crops of Madagascar include rice (45%), cassava, maize, beans, potatoes, lima beans, and sweet potatoes, among others. Industrial crops include peanuts, sugar cane and cotton, while cash crops include pepper, vanilla, coffee, and cloves, among others (Table 1). Rice is the single most important crop and is the dietary mainstay of the Malagasy people. Cropping areas are shown in Figure 2. The national livestock herd includes more than 10,000 cattle, concentrated in the western and southern regions. Poultry and swine production also exists. The crops most subject to locust damage are rice and maize. Other food and cash crops can also sustain damage, depending upon the stage of growth and population level of the pest, and some losses undoubtedly occur in grasslands and will affect cattle production.

Madagascar is currently not self-sufficient in agricultural production, it must import to meet its food needs. Therefore, any factor, such as drought or pestilence, which has an adverse effect on agricultural productivity may be considered a major economic and social threat.

Figure 2. Major Crop Growing Areas of Madagascar

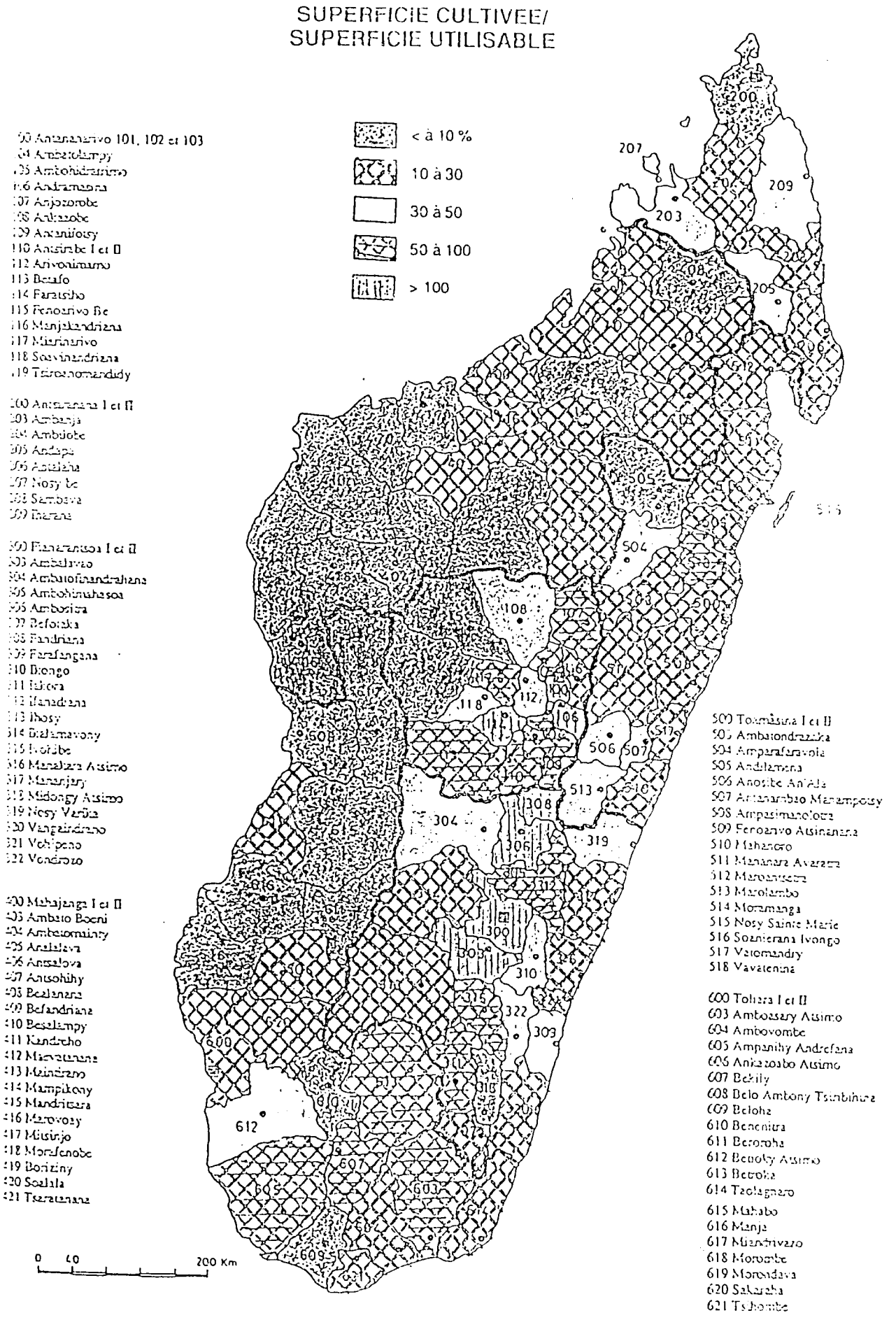


Table 1. Madagascar Crop Production 1981 to 1989.

* Superficies: (Ha x 1,000)
Production: (T x 1,000)

MADAGASCAR	1981		1982		1983		1984	
	Superficies	Production	Superficies	Production	Superficies	Production	Superficies	Production
Food crops								
Rice	1185.3	2011.4	1188.8	1970	1188.8	2147	1170.1	2131.1
Cassava	287.2	1670	313.7	1898.3	329.2	1992.2	336.1	2047.1
Maize	125.9	120.6	118.1	113	126.4	132	132	141
Beans	45.9	35.5	46	36.6	47	38.6	44.2	36.8
Potatoes	26.3	160.6	29.2	200.8	38.5	252.7	40.7	263.5
Pois de cap	5.3	5	4.8	6.2	4.9	5.8	6.3	6.1
Sweet potatoes	85.7	397.1	86.4	356.3	96.4	463	97	462.5
Industrial crops								
Peanuts	35.5	32.9	32.7	31.7	32.3	31.1	33.1	31.5
Sugar cane	41.5	1420.3	47.6	1408.5	57.1	1615.8	53	1560
Cotton			17.4	25.5	19.9	26.3	23.2	34.6
Export crops								
Pepper	5	2.9	6	2.5	6	2.6	6	2.8
Vanilla	25.7	4.3	25.4	5.5	26	2.4	26.3	6.9
Coffee	217.5	83.4	218.5	81.2	223	80.8	223.1	81.4
Cloves	72.5	10.8	73.9	10	75.5	4.2	76.7	18

MADAGASCAR	1985		1986		1987		1988		1989	
	Superficies	Production	Superficies	Production	Superficies	Production	Superficies	Production	Superficies	Production
Food crops										
Rice	1080.4	2060	1065	2116	1093	2178	1111	2149	1146	2380
Cassava	350.5	2142	359.2	2190	311.2	2178.4	333.2	2136.3	342.4	2277
Maize	140	140.2	148	152.8	139.9	158.1	148.9	156.4	151.3	160.4
Beans	46	35.7	48.1	42.2	47.9	39.5	46.4	36	46.2	37.9
Potatoes	40.7	263.6	40.8	263.9	39.6	266.6	39.4	270.1	38.9	271
Pois de cap	5.3	5.8	5.5	6.3	5.8	6.6	6.2	7	6.3	7.2
Sweat potatoes	90	449	93.6	467.1	92.2	466.7	89.9	466.9	91.2	483.2
Industrial crops										
Peanuts	32.6	31	33.3	32.5	33.1	31.8	32.6	30.2	33.3	32.3
Sugar cane	60.1	1744.1	59	19500	59.5	1980.6	60	1985	61.4	1990
Cotton	32.9	42.9	42.8	41	22.1	27.2	26	31.8	29	41.4
Export crops										
Pepper	6	2.8	6	2.8	6	3	6	3.5	6	3.3
Vanilla	26.6	7	26.8	3.3	27.4	6.2	27.4	6.8	28.6	7.8
Coffee	223.2	78.5	224.2	82.2	223.9	80.7	225	83.5	238.1	88.2
Cloves	77.1	13.5	77.1	7.1	77.2	6.5	74.9	10.1	60.5	7.1

3.3 Locusts

There are two primary acridian species of economic importance found in Madagascar, the Migratory Locust (Locusta migratoria capito), and the Nomadic Locust (Nomadacris septemfasiata). Of these, the Migratory locust is considered the significant pest, due to its ability to increase population numbers rapidly and migrate into crop growing areas. The Red Locust will be seen at some level almost every year, but does not usually cause serious crop damage. Although the Desert Locust (Schistocera gregaria) may be found on occasion in Madagascar, the environmental conditions of the island do not allow this insect to become a threat to agricultural crops. Several species of non-migratory grasshoppers exist, but are not considered a problem.

3.3.1 Migratory Locust

Historical records, ranging as far back as 1617, show that the Migratory Locust can reach high population numbers and cause considerable damage to agricultural crops in Madagascar. Significant outbreaks with infestations over 500,000 hectares have been recorded over the past 100 years during the following general time periods:

- 1880 to 1888
- 1899 to 1904
- 1909 to 1915
- 1921 to 1929
- 1939 to 1957
- 1960 to 1962

One of the initial breeding areas is in southern Madagascar, in the Horombe plateau, with larval development likely in October with the first rains. Historically, breeding has tended to continue in the southwestern areas, with a third generation along the coastal areas between Beheloka and Lavanono. A fourth generation will move into the northern areas around Mahajanga, returning south in September or October. Breeding may occur in other parts of the western and central regions, depending upon favorable environmental conditions. This locust must breed continuously or die out. Unfavorable environmental conditions or high winds will reduce population numbers significantly. As with other such locusts, the Migratory Locust has both a solitary and gregarious phase.

During unfavorable environmental conditions, the locust will be in the solitary phase, with small populations residing in isolated locations. During this phase, the locust does not cause noticeable agricultural damage, as it feeds primarily on grasses.

When the climatic conditions of temperature and rainfall become favorable, locust numbers increase, causing a phase change from solitary to gregarious. The gregarious populations move together, allowing increased opportunity for reproductive activities, and causing major crop damage when a swarm moves into an agricultural area.

This species can potentially have four generations per year, one during the dry season, and three during the wet season. Population numbers will remain fairly stable during the dry season generation, but will fluctuate either positively or negatively during the wet season. With favorable environmental and breeding conditions, significant population increases can occur with each succeeding generation during the wet season. With gregarious populations, numbers can increase so rapidly that extraordinary control operations are required for crop protection operations.

Although past A.I.D. intervention with locusts in Africa has been in the emergency control of swarms, this approach carries excessive costs and has limited overall impact. Further, such intervention is also environmentally costly because of the enormous quantities of pesticides used. A more reasonable approach is preventative control. This relies heavily on good survey, immediate targeted intervention, with control actions aimed at larval control, rather than swarm control. In addition, several reasonable alternatives to chemical pesticides exist, and should be pursued whenever possible.

The nature of locusts 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 historical sites of origin in southern Madagascar must be surveyed on a continuing basis, with spot treatment operations effected on an as-needed basis. The preference for using less volume of pesticide in a preventive program should be encouraged. Assistance to the ALS for operations involving the locust should also consider training, operations planning and preparation, survey, and early intervention.

3.4 Locust Management - Overview

3.4.1 Past Locust Campaigns

As the Migratory Locust is part of the natural ecology of Madagascar, periodic upsurges are a common and a normal part of the biological system. However, with the introduction of agriculture, this locust, as with other insects which are considered "pests", will readily take advantage of crop lands

which are placed in their natural habitat. Since people have been living on this island, the Migratory Locust has followed its natural life history pattern, and periodically contributed to severe crop losses.

It was not until the French occupation and subsequent colonization of Madagascar that the magnitude and duration of such invasions and outbreaks were well documented. In order to protect exploitative cash crops, the French have extensively studied the biology and control of this insect. Beginning in the 1950s, with the chlorinated hydrocarbon insecticides and small aircraft, the French carried out several successful population suppression and crop protection campaigns.

Several Anti-Locust stations were set up in the southern regions and were maintained well into the late 1960s with French funds and expertise. With a lessening of French funds, and difficult economic conditions in the Madagascar government, these stations have declined in their capacities and have experienced substantial physical deterioration.

The situation in Madagascar with respect to the National Anti-Locust Service as of this writing (July 1992) is severely inadequate. The Service has few vehicles and little essential support equipment to treat the vast and rugged southern and south-central regions. In addition, the majority of the expertise which had been trained by the French is no longer in the Service.

Over the past several years, the Anti-Locust Service has had some assistance from the German Government (GTZ) in the form of pesticides, ground treatment assistance, and some limited aerial treatment assistance. However, this has had little effect on the status of institutional capacity.

3.4.2 Crop Loss Assessment

In considering locust damage to agriculture, there is a basic assumption that these insects cause significant crop loss and therefore must be controlled. The amount of crop yield that is lost due to an infestation of these insects is a particularly important parameter and should be determined as soon as possible to assist in the decision as to both the level of funding needed, and the amount of pesticide to be discharged into the environment. Crop loss information is therefore needed to guide both the Madagascar ALS and A.I.D. (as well as other donors) in the level of response which may be needed. Once the infestation levels can be related to yield loss, management operations can be more realistic in the level of effort needed.

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, especially in the south, may experience high losses. Costs of grain transport over long distances may be more expensive than those of a locust control program. Losses in grasslands are more difficult to assess than in crop lands, because the impacts are on wandering grazing animals, and are thus are more indirect.

Crop losses will vary geographically, with extreme damage occurring near areas seeming untouched. Undoubtedly, the distribution and success of control efforts among the regions of Madagascar in proportion to infestation levels are not uniform from year to year. Good crop productivity data are currently unavailable. If estimates of locust 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 could be made. This SEA strongly urges that such data be compiled and analyzed.

3.4.3 Predictability/Breadth of Operations

Locust infestations are not easy to predict in advance. Rainfall distribution seems to be the best single predictor, but locusts often occur in patterns not obviously related to any easily measured factors. Because of this, surveillance is essential for the design of tactics to maintain low locust populations and prevent outbreaks. Because rainfall and the vegetation that follows it is important, satellite derived Greenness Maps may be utilized as additional guidance to supplement field surveillance.

Field survey is essential in any locust management program, and must be given high priority by both the ALS and assisting donors. Included in the survey program must be a sound knowledge of pest biology, and an understanding of the impact of environmental conditions. Survey results must be relayed to the central ALS facilities in Antananarivo in a timely manner, so as to allow administrators time to direct logistical operations and needed materials.

The organizational structure responsible for control activities is the Malagasy ALS. Although this organization has some expertise needed for a responsible management campaign, additional training programs should be considered. The ALS is responsible for planning, survey, operational control and campaign assessment, and must be trained to use pesticides in a safe and environmentally sound manner.

For organizational purposes, the FAO should be considered the official donor coordinator for locust control activities on behalf of the GOM and should be supported in continuing that role. In addition, the ALS should be encouraged to work closely with the FAO and other donors to insure that repetition of unneeded material or pesticide donations and excess stock build-up does not occur.

3.4.4 Level of Infestation

Locusts vary over a wide range of population levels in their natural habitat, depending upon rainfall and other climatic and environmental conditions. A migrating infestation of locusts, depending upon wind conditions and movement patterns, have a significant impact on agriculture, because crop infestation levels depending upon the numeric density and life stage of the insect. In Madagascar, locusts will be a problem almost every year to some degree in various locations. Major outbreaks, however, are widely periodic and will fluctuate greatly over time periods of five to ten years, if not longer.

For management planning purposes, potential impact on ultimate crop yield can be divided into levels of infestation. These levels are quantified in relation to the intervention threshold level. The intervention threshold (also called economic threshold) is very specific to the crop, life stage of crop, insect species, and insect life stage. This concept is discussed in more detail in section 3.5.5 of this document.

Level 0 describes a low density of locusts, with density levels well below the intervention threshold level for a given species. Crop losses from this level of infestation are minor and localized. The Crop Protection Service is capable of carrying out any needed treatment programs without donor assistance.

Level I describes a situation with locust populations at levels which may require some donor assistance to avoid crop loss. In this case, pest densities will be at or slightly above the intervention threshold levels. The ALS may need assistance to cover additional costs, including materials and equipment needed to reduce population levels.

Level II describes high locust densities with high numbers in both crops and pasture lands. Here, locust densities will exceed the intervention threshold level. The capacity for ALS management will likely be exceeded. Significant crop loss is probable without additional donor assistance and intervention.

Level III describes a situation involving very high locust populations extending over a large area. Again, densities exceed the intervention threshold and exceed ALS capacity. This situation will require considerable donor assistance and intervention to avoid locust outbreaks and substantial crop loss.

Because of the complex effects of crop loss, investments by donors at each of the four intervention levels may be justified. At each level, assistance which builds sustainable infrastructure is appropriate.

3.4.5 Thresholds of A.I.D. Assistance

Ideally, the ALS is expected to maintain an ongoing insect management program during periods of normal pest levels. This program should include efforts to reduce human health risk, protect environmentally sensitive habitats, and minimize pesticide use through cultural, biological and traditiona ans of control. In decisions on assistance to the ALS for lo management activities, A.I.D. will examine both the pest situation and the capabilities of the ALS. Decisions will be made in such a way as to minimize the amount of pesticide used.

If A.I.D. does choose to participate in an assistance program, it is important that support be coordinated with other donors and the GOM to achieve a reasonable and balanced program. Assistance for such a program should emphasize the principles of Integrated Pest Management (IPM) (as discussed in section 3.5.5), in that all available management resources should be considered. While probable crop loss will be a criterion for A.I.D. involvement in control efforts, sustainable infrastructure development and cost/benefit ratio will also be considered. Participation by A.I.D. in emergency operations will be carefully tempered with an examination of what long-term benefits will be achieved in addition to an insect population decrease. Because the use of pesticides in Madagascar has increased over the last several years, A.I.D. will assist primarily with a program emphasizing good survey and use of non-chemical control methods wherever possible.

The level of USAID/Madagascar participation in a locust management program should not only be related to the extent and severity of the problem, but also to the extent such assistance will make the ALS more sustainable. The actual level of intervention assistance will depend upon a number of variables, including insect density, crop conditions, ALS capacity, environmental conditions, and the potential for a major outbreak.

Prior to the implementation of U.S.-funded assistance, a through analysis of needs is necessary. In evaluating areas of

assistance, USAID/Madagascar should be responsive not only to the requests of the GOM, but must further ascertain what materials the ALS already has, and what other donor supported programs are planned or implemented. Supplying the ALS with an overburden of pesticides, unneeded materials, or poorly planned training will not assist in managing locusts. In addition, an independent verification of pest identity, density, distribution, and potential impact should be made by a qualified technician prior to fund committal and allocation. In this regard, USAID/Madagascar will likely request technical assistance from AID/Washington and/or REDSO/ESA in Nairobi.

3.4.6 Disaster Level of A.I.D. Participation

Should a substantial and extensive locust outbreak occur in Madagascar, a large scale operation may be needed as a last resort to protect crops, and reduce pest population levels. At such a level of intervention, risks to humans and the environment will be high, but the alternative, substantial crop loss, may make intervention unavoidable.

In a situation calling for large-scale intervention, all possible safeguards must be instituted, with control operational decisions built on the following hierarchy: 1) crop protection, 2) environmental protection, 3) population reduction. This places the highest priority on crop protection, and the lowest at reducing pest population numbers (where the focus is on future generations, population reduction has not proven to be effective).

However, during a large-scale operation, the rate of accidents, overuse and use of incorrect formulations are likely to increase, because of the increased pesticide use and the pressure of panic treatments. The most important function of the GOM under these conditions is to institute greater local control (for example, use of Village Brigades), communicate effectively with the affected population, to describe the necessity of the emergency measures, and to ensure to the extent possible the safety of the population and the environment. Operations at a local level, accompanied by appropriate training in pesticide use and safety, is greatly preferred to massive treatments by large aircraft.

The position of USAID/Madagascar on pesticide application is to support the judicious use of such chemicals for the control of food crop threatening pests. The first line of defense must be field survey work to monitor the population level of a particular pest. Proper monitoring will generally allow sufficient time to plan a strategy of control. Survey operations will also alert officials should pests be breeding at a faster rate than

expected, or if a significant migration has occurred. The first line of defense is spot treatment via ground applications. This involves manpower-intensive measures to directly attack the sites of the infestation at early insect life stages. Aerial application is considered a last resort. This control measure is used when all others have proved ineffective or the magnitude of the threat exceeds the indigenous ALS capacity.

3.5 Locust Management Operations

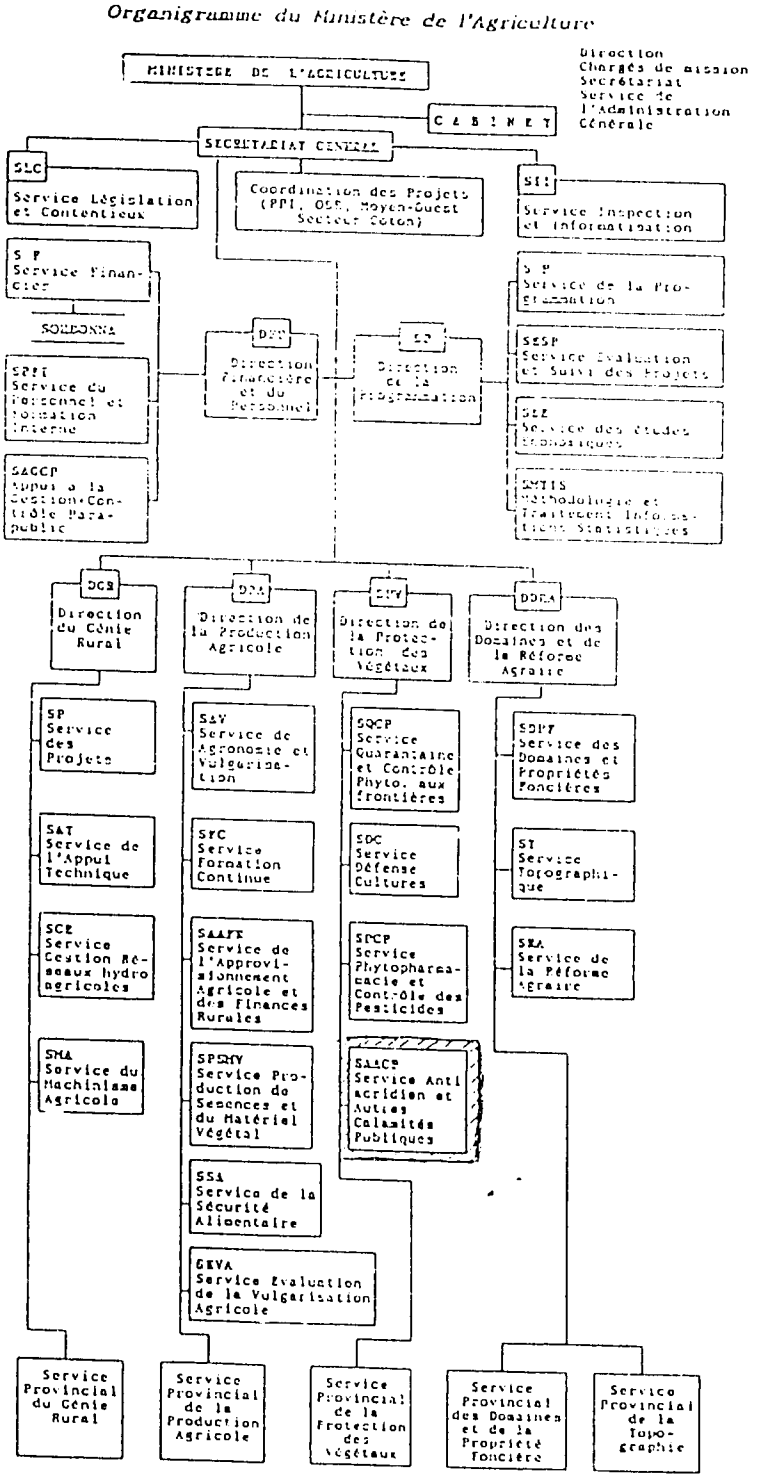
3.5.1 Crop Protection Service/Anti-Locust Service

The Madagascar Crop Protection Service (CPS) is structurally under the Ministry of State/Agriculture/Rural Development, within the Ministry of Agriculture (Table 2). The Anti-Locust Service (ALS) falls within the CPS, and is divided into three Divisions: Betioky Southern Anti-Locust Center, Technical Assistance and Training, and the Division of Disaster Assistance. Including the Betioky Center, there are 17 Regional Anti-Locust Stations. Currently included in the ALS capacity are 5 vehicles for survey and treatment operations, 2 heavy trucks for fuel and pesticide movement, 16 motorcycles, and 3 bicycles. In addition, there are 4 vehicles which need parts to be fully operational. There are 15 radios divided between the 17 ALS Stations, and some 100 ALS personnel. Additional resources to date include 94 hand powder application sacks, 82 ULV battery sprayers, and 114 backpack sprayers.

Madagascar is divided into five Locust zones, each with several Anti-Locust Stations, with each zone station equipped with supplementary equipment and pesticides for that zone. The stations are arranged as follows:

ZONE	STATION
Ankaraobato	Manja, Befandriana Ankaraobato
Tulear	Sakaraha, Tulear
Ejeda	Betioky, Beahitse Beheloka, Ampanihy Saodona, Ejeda
Ambovombe	Bekily, Amboasary Tsihombe, Beloha Ambovombe
Ihosy	Ranohira, Ihosy

Table 2. Structure of the Agricultural Ministry



Due to insufficient equipment and resource allocations, the ALS is capable of carrying out only minimal locust management and crop protection activities, when locust population levels are low (level 0, section 3.4.4). Although ALS action plans are developed on an annual basis, material and equipment allocations are far below those needed to fight any substantial numbers of either larval or swarming locusts.

Since vigorous survey and early season management can both save both valuable funds and resources, and is considered to be far more environmentally sound than late-season emergency operations, it is recommended that the GOM more adequately support ALS survey operations. However, the reality is that additional donor assistance will likely be required to ensure a reasonable level of survey and management capacity within the ALS. In regard to U.S.-funded assistance involving chemical pesticides, the information, recommendations, and regulations discussed in this SEA and the PEA must be observed and reckoned with in project design and implementation.

Ideally, by developing a strong base of trained personal and a well-maintained fleet of sturdy vehicles and equipment, the ALS will be able to hold impending locust outbreaks to a minimum. This will result in considerably less pesticide being used than if these pests were allowed to reach high population levels. In this regard, it is especially important to involve villagers and farmers living in invasion areas in early season control endeavors. These types of efforts, combined with improved legislation and regulations will greatly lessen potential negative environmental impact of pesticide use. Any assistance A.I.D. can offer to build such a institution, with full participation and involvement of the Malagasy CPS and ALS, will be a far more effective investment than the immense amounts which have been spent on past emergency operations (with little effect on sustainable infrastructure).

3.5.2 Survey and Control Preparations

In order to keep locust population numbers below levels where crop loss is imminent, and reduce the environmental impact of pesticide use, it is important to survey early in the season, and to implement control activities immediately. Trained personnel, and equipment in full working order are required to do this. The main elements to be included in locust survey programs are:

- Full knowledge of the physical and temporal distribution of the pest species.
- Monitoring of environmental conditions and changes which might lead to increased numbers of pest species. This will require an adequate knowledge of pest species biology, the

status of environmental conditions, and how these conditions can be augmenting or limiting factors.
- A vulnerability assessment in terms of crops threatened by the pest species, including relative importance of crops, and the crop stage of development, including an understanding of the vulnerability of the human population likely to be affected.
- The availability of pest management support resources to be mobilized for control: pesticides, application equipment, as well as logistical and technical support.

Prior to the main agricultural season, the ALS should ensure that each Anti-Locust Station is equipped and prepared to face a low infestation level (level 0 in section 3.4.4) of locust management. Adequate preparation would include: a working radio system, operating vehicles and application equipment, protective clothing and safety equipment that are clean and ready to use, and the needed amount of pesticides carefully stored and ready for use.Specific stations should be better stocked to deal with higher probability infestation areas.

3.5.3 Village Brigades

Farmers can play a major role in a control campaign -- from reporting population levels to actively protecting crops from larval infestations. However, with chemical pesticides, this requires farmer and village training programs. Both A.I.D. and the FAO have had a high degree of success in this area with "Train the Trainer" programs. These have been implemented on a large scale basis since 1987 in areas of Africa where locust or grasshopper infestations are endemic. This technology likely can be applied successfully in Madagascar.

Each Village Brigade typically includes 10 interested and enthusiastic villagers. The participants will receive 3 days of intensive training (covering the identification and biology of both local pest and beneficial insect species, the fundamentals of good survey techniques, and the safe handling and use of pesticides); and are then given a small quantity of pesticide, a set of protective clothing, and necessary application equipment. Village Brigade members are responsible for locust control at the village level and are supported by the CPS or ALS. An entire village may be trained during the year by members of a Village Brigade.

The support of the CPS or ALS is essential to the Village Brigade. Once formed, the Brigade members must receive needed materials and technical support within a reasonable time frame to achieve crop protection. While a trained group may in theory be able to creatively defend crops against pests without resources,

in reality, they will loose both enthusiasm and expertise without support.

3.5.4 Ground and Aerial Operations

The use of spray aircraft should be considered a last resort in a U.S.-funded locust or management program. With an attentive survey program, combined with rapid deployment of ground pesticide application teams, it is possible to conduct a management campaign without the use of spray aircraft. A.I.D. fully supports this concept, and needed training programs for survey and ground teams. In addition to the basics of survey techniques, pesticide safety and application, such training must encompass a through background knowledge on pest species that require control.

While aircraft can be effective management tools, and may be justifiably needed during locust outbreaks, they should be used with caution. This is because: 1) aircraft carry and spray larger quantities of pesticide than ground equipment, and therefore are more likely to have an environmental impact; 2) They are expensive to run and maintain, and are unlikely to be sustainable without a high level of outside input; 3) Assumed use or support by donors may result in less attention by the ALS in the maintenance of a good survey and ground control system.

The Madagascar ALS has access to two Pawnee PA-18 for its aerial spray operations. Due to the limited range and capacity of these aircraft, only small areas can be treated. Should a significant infestation occur, additional and larger aircraft would have to be brought in from other areas. Due to the lack of in-country support, any air operation would have to be fully self-supportive. While aerial control operations can treat inaccessible areas relatively quickly, aircraft operation and logistical support is very expensive, and large amounts of pesticides will likely be required. In addition, pesticide drift is difficult to control and will be a factor in village areas and around ecologically sensitive zones.

In light of the limitations concerning aerial control operations, it is a good policy to use preventive ground control operations whenever possible. The components of ground operations are:

- training and equipping farmers and Village Brigades;
- early season surveys;
- weather monitoring;
- increased survey and ground application teams.

3.5.5 Integrated Pest Management - IPM.

Integrated Pest Management utilizes all available control methods to achieve the most economically and environmentally sound management program. It is considered to be the preferred approach to pest control. IPM is not an alternative to the use of chemical pesticides; instead it is an integration of methods which may reduce use of pesticides by employing them more judiciously. Determination of intervention thresholds, correct timing of sprays based on pest population dynamics, and use of non-chemical control agents are among examples of modern and prudent pest management methods.

IPM can decrease pest losses, lower pesticide use, and reduce overall operation costs, while increasing crop yield and stability. Successful IPM programs have been developed for a variety of pests on various crops. Specifics of an IPM program will depend on the crop, cropping system, pest complex, economic values, social conditions, availability of personnel, and other factors and constraints. The following steps illustrate the development of an IPM program.

Step 1: Identify the Major Pests, and Establish Intervention Thresholds.

Dozens of potentially harmful species may infest a crop. However, only a few pest species cause substantial crop loss. The pests which recur at intolerable levels on a regular basis are known as primary pests, and are the focus of IPM programs.

The criterion that determines whether taking action to control a harmful species is profitable is called the intervention threshold (or economic injury level). The intervention threshold is the point above which control actions should be taken, and below which no actions are necessary. The economic injury level may be expressed in different ways depending upon the crop and the pest.

Examples of injury level indicators could be:

- Numbers of insects per plant or per square meter.
- Percentage of fruit damaged by a given pest.
- Numbers of weeds per square meter.

Several factors will influence the intervention threshold for a specific pest: crop variety and stage of development, value of the crop, presence of natural enemies, cost of control measures, as well as external costs to health and the environment. The intervention threshold depends on the relationship between the pest intensity and the yield loss, and the economics of reducing the damage. It will therefore change as these variables change. The intervention threshold developed in one area will not likely be appropriate for use in another area.

Research is needed to determine the initial intervention threshold. This should be thoroughly tested in actual field conditions to verify effectiveness. The level can be refined as

more information becomes available, and as it is used in the field.

Step 2: Select the Best Mix of Control Techniques.

All pest management methods and practices should be considered for an IPM program. First consideration should be given to use of preventive measures:

- Resistant crop varieties.
- Biological control (conservation or augmentation of natural enemies already present or introduced)
- Cultural control (cultivation, crop rotation, use of pest-free seed and planting stock, fertilizer management, and inter-cropping)

Farmers will likely already be using one or more of these preventive measures. It is therefore important to talk to the farmers before determining which measures are needed.

Pesticides should be used only if no practical, effective, and economic nonchemical control methods are available. Once the pesticide has been carefully chosen, it should be applied only to keep the pest below the intervention threshold. Pesticides will impact other organisms besides the pest, and may cause harm to humans, livestock, honey bees, natural enemies, and the natural environment.

Step 3: Monitor the Fields Regularly.

The growth of pest populations usually is related closely to the stage of crop growth and weather conditions. However, it is difficult to predict the severity of pest problems in advance. The crops must be inspected regularly to determine the levels of pests and natural enemies, and crop damage.

ALS survey personnel and agricultural extension agents can assist with field inspections. They can train farmers to separate pests from non-pests and natural enemies and to determine when crop protection measures, perhaps including pesticides, are necessary.

Step 4: Use All Control Methods Correctly and Safely.

Each pest control method has both advantages and disadvantages. ALS and Extension agents should learn as much as possible about each control method. Education programs should be developed to teach farmers how to use the available control methods safely and correctly.

Step 5: Develop Education, Training, and Demonstration Programs for Extension Workers.

Implementation of IPM depends heavily on education, training, and demonstration to help farmers and extension workers develop and evaluate the IPM methods. Hands-on training conducted in farmers' fields (as opposed to a classroom) is a must. Special training for extension workers and educational programs for government officials and the public are also important.

Integrated Pest Management (IPM) is a sensible approach to pest control whereby all existing control methods (pesticides, biological control, cultural control), mitigating factors, environmental concerns, climatic conditions, and ecosystem inter-relationships are integrated to assist in control operation decision making. While pesticides are part of the total IPM strategy, other methods are considered, with the choice dependant on the methods that most closely fit the situation. Timing of pesticide application is an important factor in IPM, with the early season approach favored because of the low amount of pesticides utilized. IPM is not a pest control method itself, but rather, a way of considering options available in light of the physical and biological environment.

3.6 Pesticide Management

While there are many methods of locust management, the method most commonly used is chemical pesticides. While pesticides kill pests, they also affect other living organisms in the ecosystems in and around cropping areas. In addition, misuse or overuse of pesticides results in higher overall operational costs. This is not only because of the direct cost of the pesticide, but also because of reduction in natural enemies in the crop ecosystem.

The possible impact of pesticides on the environment and associated health risks to humans makes the way pesticides are selected and used an important aspect of management programs. Due to the unique ecology and bio-diversity of Madagascar, pesticides should be used with extra caution, and only when necessary.

To use a pesticide in a specific area at specific times, it is necessary to have detailed knowledge of the physical and chemical attributes of the product, the ecology of the area to be treated, and the biology of the pest to be treated. Pesticide selection for locust control requires the following concerning the pesticide itself:

- Effectiveness at low application rates;
- Minimal effects on nontarget organisms, including people and animals, and specifically predators and parasites of locusts;
- Minimum persistence of residues on and in native fauna and flora, water, soil, and crops;
- Low toxicity and ease of handling;
- Good storage capacity;
- Compatibility with existing application equipment.

3.6.1 Pesticide Selection and Distribution

Although a number of pesticides have been used in Madagascar against locusts in the past, any pesticide involved in an operation funded by the USG must be approved for use in the United States by the Environmental Protection Agency (EPA). Several approved pesticides are listed in the Programmatic Environmental Assessment (PEA), and this should be referred to during both the planning and implementation of phases of locust control management. In addition, regulations governing the use of a particular pesticide, as set forth on the label, must be followed.

Malathion, **Acephate** and the three synthetic pyrethroids (**Cypermethrin**, **Lambda-cyhalothrin** and **Tralomethrin**) are among the pesticides preferred for use in terrestrial ecosystems. For use near aquatic ecosystems (in all cases with the possibility of contamination of water), **Acephate** would be the pesticide of preference from an environmental standpoint, as it is a systemic, and best used for larval control. In addition, Acephate is considered one of the safest pesticides in use. **Carbaryl**, suggested by the PEA, is toxicologically acceptable but is more difficult to store and apply (especially from aircraft), than other approved pesticides and is very toxic to bees. **Diazinon** and **Chlorpyrifos** are registered for use; potential environmental problems indicate they should be used with caution. **Fenitrothion** should be used only with extra precautions and with mitigative measures. Water resources in Madagascar should be protected from pesticide contamination as much as practicable. Therefore, the pesticides preferred for terrestrial use should be the ones favored for A.I.D. procurement.

Chlorinated hydrocarbons, such as **Dieldrin** and **Lindane**, are <u>not acceptable for use under any circumstances</u>, due to their environmental persistence, bioaccumulation, and acute toxicity. It should be noted that U.S.-funds cannot be used in any way whatsoever in connection with these pesticides. This includes funding any aspect of ground application or aircraft which spray chlorinated hydrocarbons, or the transport of such materials, among others.

Pesticides in Madagascar are procured through three major supply sources: manufacturing and formulation by local companies representing foreign agro-chemical firms; imports by major multinational chemical companies; and donations from the international community. The CPS is responsible for maintaining and distributing pesticide stocks in Madagascar, through centers in regional capitals. Distribution usually takes place prior to the agricultural season, so all key management elements can be prepared for any level of infestation. Pesticides are further distributed to the ALS, where stocks are placed as needed at the Anti-Locust Stations. Pesticides are also distributed

commercially in the private sector, with some 21 companies operating in the country.

3.6.2 Pesticide Labeling

Pesticide labeling is a way to give important information to the pesticide user. The label is the main and often only medium for instructing users in correct and safe use practices. The labeling process should go hand-in-hand with in-country pesticide registration. Both registration and proper labeling require good solid legislation at the national level. It is important that the GOM draft further legislation on approval and control of pesticides, including a legal framework that will require more complete pesticide labeling and registration in Madagascar. A strong licensing and labeling program by the GOM would be an important step in achieving safe use of pesticides.

The pesticide product label can be effectively used to communicate a number of important properties of the pesticide and precautions appropriate to its use. In addition to directions for use, the label should include needed protective measures, first aid measures, precautions recommending against use in certain environments, methods of container disposal, and application rates for particular pest species.

Pesticide labeling in Madagascar tends to be quite variable. In general, pesticides in the original container carry a label with adequate information for application. Some labels, though not all, contain some information on first-aid or disposal. Unfortunately, much of the CPS and ALS stocked pesticide containers have either lost what labels did exist, or were rended illegible through handling and exposure.

While labeling must be specific to local needs and the social environment of Madagascar, the FAO has prepared a global set of guidelines which can assist a labeling program. In addition to enacting legislation, the GOM should insist that donated pesticides be labeled in comprehensive language as required by donor country law, and be in French and Malagasy.

3.6.3 Managing Pesticide Stocks

A well maintained and secure pesticide storage facility is required before initiating a U.S. pesticide donation. With a good pesticide management system in place, both donated and purchased pesticides can then be controlled and utilized as needed. A good storage area should have a fenced and covered area for the pesticides. A pesticide storage warehouse should:

1) be isolated from dwellings in order to avoid fire, leakage, and water contamination;
2) be supplied with water in order to clean spills and fight fire;
3) be aerated to avoid toxic fume concentration;
4) have a current inventory of pesticide stocks;
5) have protective gear such as suits, boots, gloves, goggles and breathing masks;
6) have a first aid kit with antidotes;
7) be staffed with trained personnel who are familiar with measures to take in cases of poisoning.

A management system is needed to record the date each pesticide arrived at the facility, how long it stays in storage, and when it is removed for use. In addition, the storage requirements for each pesticide must be posted and known by the management staff. Stored pesticides must be tested periodically to insure that the active ingredient is as described on the label, and that the formulation concentration is correct. Also the disposal of unused and obsolete pesticides, and the destruction of their containers, must be part of the management system.

Success of locust control campaigns depend on availability of pesticides in the areas which need treatment. Pesticides should be placed in safe and secure storage areas as close as possible to agricultural areas which will likely need treatment. In Madagascar, pesticide storage areas are associated with the CPS Operations Bases and ALS Stations. At the CPS Operations Bases, a monthly inventory of products and materials should be made and sent to the Crop Protection Service in Antananarivo. Distribution of products to Bases is done according to need and severity of the locust threat, as well as the degree of isolation during rainy season. Pesticide stocks must be securely in place at bases and ALS Stations before the rainy season.

The pesticide storage facilities in Madagascar range between stable and precarious. Unwanted stock accumulation is a very real problem, as discussed below. A lack of planning and coordination has resulted in stockpiles of pesticides at some bases, and shortages at others. This seems to be a result of a lack of training in the managerial aspects of pesticide storage.

Storage centers maintained by CPS are believed to be somewhat safer than most of the ALS storage areas. Simple storage safety measures could be implemented to greatly increase the efficacy of the ALS storage facilities. These include keeping stocks secured and out of the weather, posting warning signs in French and Malagasy, and preventing the storage of pesticides in living quarters.

In addition to management of the pesticides themselves, the ALS Stations must adequately manage pesticide application equipment. Due to inconsistent donor contributions, Madagascar has accumulated several different types and brands of spray equipment. This equipment is rarely interchangeable or compatible in regard to spare parts and repair. Nevertheless, the ALS Stations must work to maintain what equipment it does have, and ensure that it is clean and in good working order.

This SEA recommends that ALS improve its pesticide storage practices. Among the changes that should be instituted are: 1) use those pesticides stored in damaged drums first and handle drums more carefully in the future so they will not become damaged; 2) do not accept any unlabeled containers; 3) store all containers on pallets away from the walls, label all batches with date-in and planned date-out, and practice the principle of "first-in-first-out; 4) impose more rigorous handling practices to prevent spillage; and 5) install a sun shade to minimize direct exposure of containers to the sun. These practices should apply to all storage areas, regardless of size.

3.6.4 Obsolete Pesticides and Containers

Once the pesticide has been used, the management operation is left with an empty container. This container can be either reused or destroyed. If reused it should only be used for the same pesticide, to store fuel, or it can be flattened for use in construction after being properly cleaned. <u>It should never, repeat never, be used to store water or food</u>. Even though the pesticide is gone, enough residue is left to cause poisoning, especially in the very young or old. Further, small quantities of pesticides will make the human body more susceptible to other diseases.

Several of the ALS Stations have storage problems, usually due to the accumulation of pesticide stocks which were not used in the prescribed season, or chemicals which have been banned and cannot be used. In many cases, containers are deteriorating, and pesticides have leaked into the floors, earth, and local environment, necessitating either repacking or disposal.

In Madagascar, empty pesticide containers reportedly are refilled with pesticides, reused by the petroleum industry or are split open to be used for roofing or other construction material. This SEA recommends that containers be primarily recycled for reuse in pesticide formulation. The use in construction and for other uses involving high probability of human contact should be strongly discouraged. To facilitate proper reuse, container sizes should compatible with reuse requirements. Small containers (i.e., liter size) should be avoided, as they provide

an increased potential for subsequent use as cooking or water containers. In addition, the ALS should periodically inspect the reformulation facilities to ensure proper handling and packaging procedures are in use.

The system of crop protection in Madagascar, in which all pesticides are the property of the state, should theoretically result in effective management and disposal of empty drums. All containers technically belong to the government and should therefore be removed from the field when empty. The Ministry of Agriculture is ultimately in charge of drum disposal. However, the reality of the situation indicates that training in this area could be extremely useful.

3.6.5 Disposal of Unwanted Pesticides

When a pesticide is no longer needed, or is degraded chemically due to heat or time it will need to be disposed of. As the majority of the obsolete chemicals are liquid products, one disposal method is high-temperature incineration at a suitable facility. Incinerators in Europe or other countries may also be used for disposal operations. Because of the current research in this area, and the potential for political ramifications, as well as the technical problems involved, USAID/Madagascar should consult AID/W prior to any pesticide disposal assistance program.

Madagascar does not currently have environmentally sound pesticide disposal options. The ALS has some 56,000 liters of dieldrin in storage. Since this material is no longer used in pest control operations, and is banned in the U.S., it should be disposed of as soon as possible. In addition, many of these containers are damaged and leaking. The German aid organization, GTZ, in collaboration with Shell Chemical are reportedly preparing to dispose of the dieldrin by high temperature incineration.

3.7 Cultural, Biological and Traditional Control Methods

Numerous non-chemical methods exist for pest management in general, and many have been used successfully against locusts. For example, crop varieties which develop at different rates from the commonly planted varieties, or which show resistance to insect attack may be applicable in the long-term. Other cultural methods, such as trap cropping, residue burning, trench digging in front of locust larval path, and inter-cropping may well have merit as well. Simple techniques such as using protected courtyards for tree seedling nurseries or covering seedlings with

mosquito netting can be effective in small scale and limited cases.

Farmer experience with traditional or innovative control methods should be encouraged and incorporated into the overall locust management program. If villagers can be recruited as participants in control efforts, such as Village Brigade, any given field can be protected with a minimum of pesticide use and expense.

Research on the field use of microbial agents in locust and control is currently being implemented by A.I.D. and other international organizations. The fungal pathogen Beauveria bassiana has been tested in the U.S. and in parts of Africa for its control potential. Preliminary results from Mali indicate that B. bassiana can be an important control agent, especially if used as part of an overall biointensive control program. Additional work will be needed to determine its specific efficacy on the Migratory Locust in Madagascar.

In working with microbial pest control agents, attention must be given to handling and application techniques. Some may have a short shelf life and must be used soon after production. In addition, the field climatic and environmental conditions will impact the microbial control agent. Formulation appears to play an important part in the longevity of the material under field conditions.

The Malagasy CPS should be encouraged in developing research programs to search for local and possibly more species-specific pathogens. Large population explosions of Locusts can be conducive to the development of epidemics of endemic pathogens. At the time of locust population collapses, a search for more effective pathogens would be appropriate. Such a search should be done in collaboration with an organization or University familiar with pathogen isolation.

Plant extracts as bio-pesticides and antifeedants may have potential for use as a component of IPM and may be appropriate for Madagascar. Many of these materials may already be used by villagers as a traditional means of pest control. Additional research in this area is needed, especially considering the variety of potential plants in the forests of Madagascar.

Other fruitful research areas might include use of synthetic insect growth regulators. These agents are considered alternatives to conventional pesticides because of their different mode of action. However, there may be significant adverse impacts on non-target aquatic invertebrates.

3.8 Safety and Health Care System

3.8.1 Public Awareness

In conjunction with any A.I.D. assistance regarding locust control efforts, it is important that the Government of Madagascar monitor both human health and the natural environment. In regard to protecting human health, it is necessary to train both the medical community and pesticide applicators of the potential hazards of pesticides, and steps to mitigate any problem that may surface. Application of a pesticide in a given area should be preceded by public awareness and extension activities and education of the users. The Malagasy public must be informed that pesticides are dangerous and that empty pesticide containers should be not be used for food or water storage. A good public information program would include:

- information on the specific pesticides and labels;
- safe methods of pesticide transport and storage;
- measures in cases of container leakage;
- conditions for pesticide use;
- safe use of application equipment;
- prevention of pesticide poisoning.

Pesticide educational programs should also be instituted by Health Engineering and Sanitary Service agents. Health education and extension programs can also provide information on first aid in pesticide poisoning cases. The inherent toxicity of used pesticide containers is an important subject area, and should be specifically directed to women who are apt to use the containers for cooking or holding water. Components of a pesticide public awareness program should include photographs, posters, and prints on cloth. These should be given to agents as visual aids to hang on walls of schools, dispensaries, and on large trees in villages and towns.

Radio broadcasts are an important part of a public information campaign, including pesticide awareness information in the form of brief safety announcements, musical programs, interviews, debates, and dramas. Discussions of pesticide regulations and legislation should also be presented, including information on which pesticides are legal and which are prohibited in Madagascar. This will allow potential buyers and users to know what pesticides should be accepted and what should be refused.

3.8.2 General Pesticide Safety Concerns

Because of the role pesticides can play in potentially increasing agricultural productivity, the Government of Madagascar regards these chemicals as a useful part of agriculture. Unfortunately, pesticides can be misused by both

farmers, CPS agents, and ALS agents, presenting hazards to the human environment and the natural ecology. Some pesticides in Madagascar are marketed illegally and fraudulently. Pesticides intended for agricultural or public health purposes may be misused for fishing, hunting, and general household insect control.

In addition to the potential for unsafe application, pesticides may also affect public health by being stored improperly. It is important to keep stored pesticides in good condition, away from humans and other animals. Any unwanted or leaking pesticides must be repacked or disposed of as soon as possible. Because pesticides have the potential for misuse, it is essential that existing legislation on pesticide use be enforced. While abuse may still occur, implementation of regulations will provide a sound base for promoting public health and environmental integrity.

3.8.3 Applicator Safety Training

A.I.D. has supported CPS pesticide safety training in the past in Africa, and has found this to be a useful and often sustainable use of funds. It is important that well trained ALS agents are available to work with any U.S.-funded pesticide donation.

The incorporation of hands-on pesticide safety and application training courses into the academic course of agronomy and other agricultural degrees is essential. This approach will allow trained individuals to interact with the actual users of pesticides.

Properly trained CPS and ALS agents, as well as agricultural extension agents are encouraged to work with farmers and Village Brigades in "Train-the-Trainer" programs. This type of training will allow essential information on pesticide safety and application to reach all who may be working with pesticides. This type of training is strongly encouraged by A.I.D..

An additional approach is an emphasis on pesticide safety training among private suppliers of pesticides. Madagascar is an affiliate of several pesticide organizations, and would likely work well with the private sector to ensure the correct use of imported pesticides.

3.8.4 Public Health Care System

The public health delivery system in Madagascar, while fairly developed, is insufficient to handle a sever pesticide

poisoning case. Regional level hospitals exist, as do smaller village clinics and health centers. However, few doctors or nurses have been trained to recognize pesticide poisoning and to use drugs and other forms of treatment necessary. All hospitals and clinics in an area which is likely to be involved in a pesticide spray operation should be provided with information materials on the pesticides to be used in the area. The personnel of these centers should be given the necessary training to recognize and treat pesticide poisonings. Information is available in the EPA handbook on pesticide poisonings (Morgan, 1989).

Because the local health care system in Madagascar is not equipped to handle serious pesticide poisonings, application crews need to be self-sufficient in handling medical emergencies. Supervisors must be familiar with safe handling of pesticides and be able to administer any needed first aid, including antidotes for pesticide poisoning. All who are working with pesticides should be familiar with the early warning signs of poisoning. Workers must be removed from contact with pesticides at the first signs of poisoning.

3.8.5 Potential for Human Health Impact

The potential for adverse effect on human health increases significantly when pesticides use is high. When large areas of the country are treated and large amounts of pesticide products are being shipped, distributed, and applied, the probability of exposure of humans (and the environment) is proportionately greater. This SEA advocates prevention of human exposure as the best approach to minimizing adverse health impacts. A major aspect of prevention is to keep locusts at low population levels with preventative control strategies, as discussed in the previous section. Another major aspect, covered in this section, is prevention of exposure to humans.

3.8.6 Prevention of Human Exposure

The general population is most effectively protected from any adverse health effects by proper pesticide application techniques. Whether or not the application is safe for the general population depends on the toxicity of the pesticide, the formulation used, the concentration of the pesticide in the formulation, the frequency of application, the kind of equipment used, and the training of the applicators in safety precautions. In areas of high population densities, treatment-free perimeters can be observed in order to avoid exposure.

This SEA advocates training, educating, and supervising the applicators as the most effective way to ensure that exposure of the general population is kept at or below an acceptable levels. Such training and supervision has to be an ongoing effort and has to be detailed enough to include the differences between individual pesticide active ingredients, formulations, and application methods.

The general public is at minimal risk if the necessary precautions are taken, but should nevertheless be informed about pesticide use. This can be achieved by a number of means, such as posters, the radio, and local news papers. Public health advisories given by radio broadcasts were effective in other countries prior to past aerial applications and should be included in plans for future applications. This is especially important in areas where people may eat locusts. It also should include public education about the dangers of improper pesticide container reuse.

Pesticide applicators are generally at the highest risk for any adverse effects, and are several orders of magnitude higher than the general population since they are handling concentrated products. In addition to the training and supervision indicated above, applicators should be thoroughly familiar with the level of danger from the pesticide, and should be provided with equipment that is in good working condition in order to minimize accidents. Such equipment may include pumps to transfer pesticides, body protection in the form of gloves, aprons and safety shields for the face to prevent dermal exposure and respirators to prevent inhalation.

It is particularly important that some form of protection is worn during the short periods while handling the concentrates. If at all possible, long sleeved shirts and pants should be used, and frequently washed. ALS logos or patches on the protective clothing items can help to induce use and care.

Exposure of applicators is mostly through the skin. Though the skin usually provides a significant barrier to the entry of some pesticides, even those penetrate into the body if the contamination is left on the skin. In addition, some pesticides penetrate the skin more readily. Therefore, applicators should wash any exposed areas of their bodies frequently. If water is scarce, the wash water could be saved for use in diluting pesticides.

3.8.7 Monitoring of Human Exposure

Simple and effective health monitoring of those involved in pesticide handling, application, and storage is essential to a good management operation. This involves teaching all involved with pesticides what the symptoms of pesticide poisoning are, and when first-aid might be required. It is especially important to use behavioral observation to decide if workers should be immediately removed from pesticide exposure.

It is doubtful that the GOM/CPS Anti-Locust Service has the capability to monitor either the behavioral symptoms of pesticide poisoning, or such blood-chemistry manifestations such as acetylcholinesterase (AChE) inhibition. Because of this, any U.S.-funded pesticide operation should be prepared to test all pesticide handlers and related workers for blood AChE inhibition. This is a fairly simple and inexpensive test, and can be performed by trained health workers in the field. The background cholinesterase level for each person involved with pesticides must be determined prior to exposure, and testing should be performed at intervals throughout the season to ensure that no worker is being overexposed to pesticides. It should be noted that testing AChE is recommended only when pesticides in the organophosphate class are used (Malathion, Sevin, etc.).

Measurement of residue levels in the environment can also be a valuable source of information for assessing exposure and determining if modifications to treatment operations are needed. The University of Antananarivo has a well functioning chemical residue laboratory which could measure actual residues deposited in residential areas due to pesticide spraying. In addition, the GOM/CPS is presently equipping an analytical chemistry laboratory. The environmental residue data produced by these laboratories, including residue data on food and feed items, can be a reliable, relevant and accurate way of monitoring environmental impact.

3.9 Environmental and Non-Target Impact

3.9.1. Environmental Impact Minimization

Due to their toxic nature, pesticides will impact both crop and nearby ecosystems. Care must be taken during the handling, transport, application, and disposal process to insure that as little impact as possible is allowed in non-target areas. In addressing this issue in regard to operational planning, risks to the environment must be considered in terms of early season management, versus late season large scale operations. The latter would involve considerably greater amounts of pesticide, and therefore a correspondingly higher risks.

Because of the additional risks incurred in late season control operations, USAID/Madagascar should support management operations designed to avoid such risks. Early season survey and management can prevent late season control operations, with significantly less pesticide usage. Preventive management operations with attention on survey operations aimed at locating and delimiting pest populations, and spot treatment operations intended reduce population numbers using as little pesticide as possible are favored.

By reducing the number of hectares sprayed, early season control operations use less fuel, reducing vehicle wear, causing vehicles to last longer. Because early season control strategy uses considerably less resources, the ALS is better able to implement it without donor assistance. This will allow a greater degree of self-sufficiency and control of the situation by the ALS itself.

If pesticide use is necessary, the type of ecosystem in the treatment area, and associated non-target species, should be a major factor determining the choice of pesticide. A pesticide's characteristics, such as selectivity, mobility in ground water, persistence, and metabolic products should be considered as important as effectiveness against target species. In addition, application methods should be considered, with ground application having less impact than aerial treatment.

The response of different animals and ecosystems to pesticide exposure varies dramatically. For example, carbaryl has only low toxicity to birds, but is extremely toxic to aquatic invertebrates and certain estuarine organisms. While application of carbaryl may be appropriate in areas providing upland habitat for birds, its application in areas important to waterfowl and migratory shorebirds, such as National Parks or Reserves in Madagascar's coastal and riverine areas should be prohibited.

Although this SEA strongly recommends against any pesticide applications in aquatic systems, acephate is relatively nontoxic to freshwater fish and invertebrates and is the least likely of the selected pesticides to have adverse effects on aquatic habitats. Acephate should be one of the preferred pesticides if applications are necessary adjacent to aquatic systems, particularly in and around fragile areas, or critical animal, bird or fish habitat. Due to its mobility in soils, however, acephate has the potential to contaminate ground water.

3.9.2 Environmental Monitoring

Part of the overall pest management system is monitoring treated areas for potential environmental effects of pesticides. Monitoring can indicate negative impacts on flora and fauna, as well as detect improper application methods which can impact human health and increase operations cost. Measuring pesticide residues in the environment is an excellent way of monitoring, and will require a residue analysis laboratory for full implementation. Pesticide use support should incorporate residue analysis into project plans, and should include qualitative behavioral observations of non-target organisms near any pesticide target areas. ALS applicators must be trained to note unusual behavior among fauna of the area.

Although monitoring is likely to produce variable results, it can be a valuable feedback tool in control operations. It can provide some general conclusions on effects and can be used in designing modifications of pest management activities. Given the large number of variables that can affect results and the limited resources likely to be available for monitoring, using mortality and population counts, and behavior observations may be the most practical ways to assess the effects of pesticide applications. Baseline conditions for an indicator species and its habitat should be determined prior to pesticide application, and post-application monitoring should be conducted at intervals sufficient to allow assessment of both immediate and long-term effects. It is also important to select species with demonstrated sensitivity to pesticide exposure.

Aquatic habitats are often critical habitat to sensitive species and migratory birds. Therefore, pesticide use near such habitats should be avoided wherever possible. Care must especially be taken when pesticides are applied during or close to the time of seasonal rains. This may lead to introduction of the pesticide into water supplies or aquatic systems in runoff. Because invertebrates are generally much more sensitive to insecticides than vertebrates, monitoring the observable effects of pesticide use on invertebrates, such as benthic organisms, should be the preferred method for monitoring aquatic habitats. Vertebrates, however, should not be ignored, as pesticide effects on them may be indirect, but no less severe.

A similar monitoring approach should be used for pesticide use in terrestrial ecosystems. Selection of soil microorganisms or other low tolerance invertebrates as indicator species is recommended. Monitoring animals of economic value or threatened status should also be required. In cases where pesticide persistence is an issue, residues should be measured. Populations of vertebrate predators, such as birds of prey, are likely to fluctuate too much to make population counts an effective monitoring tool. However, reproduction monitoring of

carnivores (e.g., observations of egg conditions, birth defects, infant mortality) may be a useful tool in determining the effects of pesticides known to effect reproductive success, particularly in cases where baseline data are known.

4.0 PROTECTED AREAS/PROTECTED ANIMALS AND PLANTS

Because pesticides will impact both crop and natural ecosystems, a system of natural resource protection is necessary. This can be accomplished by setting aside areas and zones where pesticides are not used, or severely restricted. Endangered animals and plants need to be taken into consideration in regard to habitat intervention. Since birds and fish are particularly vulnerable to the direct and indirect impact of pesticides, these organisms need to be given special respect. Some areas should be set aside to be protected from pesticide use no matter how great the perceived pest control need.

Protection of animal and plant species and their habitat in turn preserves the regional biological diversity. In addition to protecting habitat and inherent existence value, Protected Areas also provide a safe place for reproduction and regeneration of wildlife after losses from drought and poaching. They provide for a non consumptive use industry (tourism) which, because it is non-consumptive, has a very high return value. In addition, protected plants may hold value for future industrial and pharmaceutical use. Protected areas can also contribute to local village economy through value-added income.

This is especially true for the unique plant and animal species of Madagascar, which exist nowhere else on earth. The island is unique in its biological diversity and level of endemism in flora and fauna. However, basic economic needs are contributing to the degradation of the forests, grasslands, coastal areas and plants and animals which may be lost forever. Soil erosion is rampant, and deforestation is at extremely high levels. **It is extremely important that any U.S.-funded locust control program involving pesticides not contribute further the environmental degradation already underway. Further, the United States should do its utmost to utilize methods and materials which have the least-toxic effects on both crop and natural ecosystems.**

4.1 Protected Animals and Plants

4.1.1 Animals

The fauna of Madagascar is unique and diverse, with a remarkable degree of endemicity, both at species and higher taxonomic levels. The great majority of native terrestrial species, in all faunal groups, appear to be dependent on forested or wooded areas. These areas, in particular, should be protected from an operation involving pesticides. Effects on non-target organisms could negatively affect those species already severely assaulted by habitat loss and increased predation.

Overall, there are thought to be well over 3 native land mammals, confined to five orders: Primates, Chiroptera, Insectivora, Carnivora, and Rodentia; some 250 different species of birds; 144 amphibians; 257 reptiles; and a large number of species of freshwater and estuary fish in Madagascar. The number of insect species is thought to be equally diverse. Additional and more detailed information can be found the following reference works (cited in full in the attached reference list).

- Faune de Madagascar, an ongoing reference, with 64 volumes published to date (1956 -).

- Biogeography and ecology in Madagascar, containing information on insects, fish, birds, and mammals (1972).

- Madagascar, un sanctuaire de la nature, with chapters on invertebrates, reptiles amphibians, birds, and mammals (1981).

- Key Environments: Madagascar, covering key fauna of the island, with emphasis on the unique biological organisms (1984).

Numerous animal species are listed as endangered or threatened in Madagascar. **Rather than listing these species here, it is sufficient to clearly articulate that no U.S.-funded pesticides or related operations will take place in or around established critical habitat.**

While protected areas and animals are covered by several Malagasy laws and regulations, enforcement is usually lax to non-existent. The listed endangered and threatened species have been noted to continue to decline despite legislation. Several animal species will likely cease to exist unless a considerable higher level of protection in brought to bear. Any U.S.-funded operation must consider the potential impact of pesticides on these already strained animal habitats and the fauna contained therein. While human life cannot be placed below that of an endangered species, the U.S. should not allow itself to be drawn

into a situation that may force such a choice. Here again, early survey and surgical treatment programs can allay such situations.

4.1.2 Plants

There are well over 10,000 types of plants in Madagascar. Out of 191 families, eight are considered endemic; out of 1289 general, 289 are endemic; considering species, some 85% are considered endemic. Much of the unique flora has been destroyed with increased deforestation, with some 70% of forest cover removed since 1958. It is likely that deforestation is increasing on an annual basis. While some limited legislation exists to protect rare or unique species, most plants are protected only by local traditions and customs. Pesticides can impact plants by removing pollinators and inducing a secondary pest situation. Any U.S.-funded locust control operation involving pesticides must respect protected areas and buffer zones so as not to contribute further to the already desperate situation in Madagascar.

4.2 Protected Areas

The unique environmental features and diverse biological organisms of Madagascar have long been recognized with efforts to protect and conserve. Several categories of protected areas exist in Madagascar (Table 3.), and are located throughout the country (Figure 3.). When engaging in locust control operations, the U.S. should, at all time, encourage the respect of these and all potential fragile areas.

Five categories of protected areas exist in Madagascar:
- Strict Nature Reserves (Reserves Naturelles Integrales)
- National Parks (Parcs Nationaux)
- Special Reserves (Reserves Speciales)
- Classified Forests (Forets Classees)
- Reforestation Zones (Perimetres de Reboisement et de Restauration)

The Strict Nature Reserves include 11 separate reserves, covering some 600,000 hectares of National Forest domain, with legislation contained in Decree 66-242 (01.06.66). The network of reserves was set up originally in 1927, and other than for scientific research purposes, access is strictly forbidden.

Two National Parks cover nearly 100,000 hectares, with legislation contained in Decrees 58-07 (28.10.58) and 62-371

(19.07.62). Access is controlled, with neighboring villages allowed to exploit certain forest products.

Covering some 370,000 hectares, the 23 Special Reserves are designed to protect certain animal and plant species, and are contained in a number of legislative decrees. Access is free, but hunting, fishing, pasturing of animals, collection of natural products, or introduction of outside species is forbidden. However, there are no supervisory personnel, and little control of the areas.

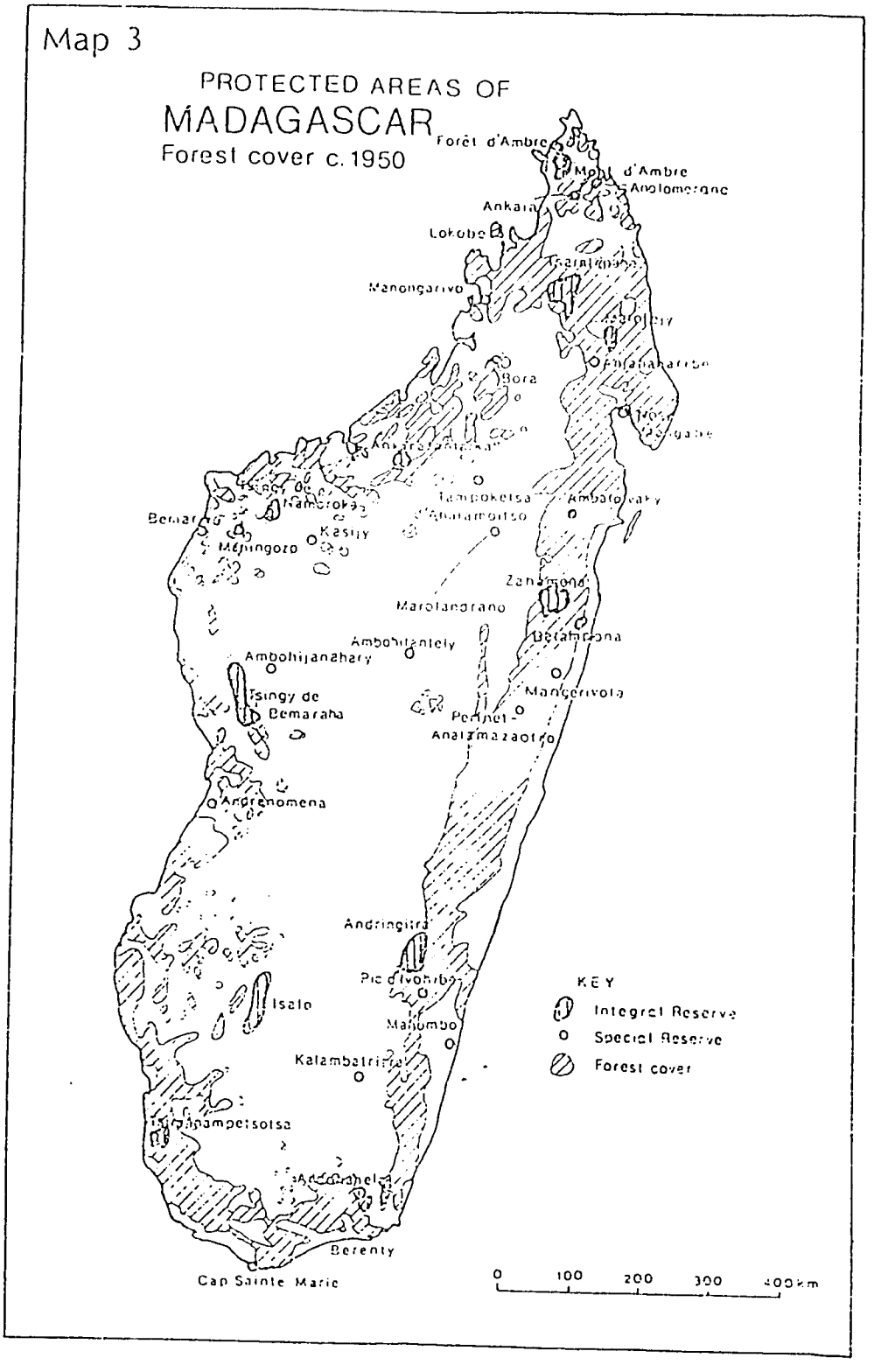
Classified Forests include 158 individual tracts and cover 2,700,000 hectares. Each is subject to ministerial decrees, however in all forest exploitation is forbidden, are considered economic reserves, and can be utilized by local inhabitants for traditional uses. Protection of these areas is dependent upon the local inhabitants.

The Reforestation zones cover some 900,000 hectares and number 77 individual areas. While similar to the Classified Forest, their primary aim is stabilization and protection of watersheds, and the prevention of erosion. Land use is regulated.

Table 3. Protected Areas

	(hectares)
National Parks	
Isalo (No. 2)	81,540
Montagne d'Ambre (No. 1)	18,200
Total	99,740
Natures Reserves	
Tsingy de Bemaraha (No. 9)	152,000
Andohahela (No. 11)	76,020
Zahamena (No. 3)	[illegible]160
Ankarafantsika (No. [illegible]	[illegible]520
Marojejy (No. 12)	[illegible],150
Tsaratanana (No. 4)	48,622
Tsimanampetsotra (No. 10)	43,200
Andringitra (No. 5)	31,160
Tsingy de Namoroka (No. 8)	21,742
Betampona (No. 1)	2,228
Lokobe (on Nosy Be) (No. 6)	740
Total	569,542
Special Reserves	
Ambatovaky (Toamasina Province)	60,050
Marotandrano (Mahajanga)	42,200
Manongarivo (Antseranana)	35,250
Analamerana (Antseranana)	34,700
Anjanaharibe-Sud (Antseranana)	32,100
Kalambatritra (Fianarantsoa)	28,250
Ambohijanahary (Mahajanga)	24,750
Kasijy (Mahajanga)	18,800
Ankara (Antseranana)	18,220
Tampoketsa d'Analamaitso (Mahajanga)	17,150
Bemarivo (Mahajanga)	11,570
Maningozo (Antseranana)	7,900
Andranomena (Toliara)	6,420
Ambohitantely (Antananarivo)	5,600
Manombo (Fianarantsoa)	5,020
Forêt d'Ambre (Antseranana)	4,810
Bora (Mahajanga)	4,780
Pic d'Ivohibe (Fianarantsoa)	3,450
Cap Sainte Marie (Toliara)	1,750
Périnet-Analamazoatra (Toamasina)	810
Mangerivola (Toamasina)	800
Beza Mahafaly (Toliara)	600
Nosy Mangabe (Toamasina)	520
Total	365,500
Classified forests	
There are 158 of these with total area	ca 2,671,000
Reforestation areas	
There are 77 of these covering	ca 823,978

Figure 3. Map of Protected Areas



Protected areas should be surrounded by a buffer zones at least 5 km wide. These are needed to avoid accidental pesticide application and possible spray drift, and to will help to minimize indirect effects of pesticide use. Within buffer zones, a higher priority should be given to the use of alternatives to chemical pesticides, and a monitoring program so that non-chemical alternatives can be applied successfully. As the capacity of the ALS to provide training in non-chemical alternatives increases, the width of the buffer zones can be increased.

This SEA supports the establishment of 5km buffer zones around all water bodies and areas containing endangered species and critical habitat. Given the importance of biodiversity in these habitats, locust and pest control programs carried on adjacent to buffer zones surrounding them should be limited to the pesticide with the lowest potential for impact on non-target species and with acceptable efficacy for the target species. If at all possible, non-chemical bio-pesticides should be used in the areas surrounding protected areas.

The implementation of fragile area protection programs must lie with the GOM itself. Enforcement of regulations to ensure sensitive areas are actually protected is to the ultimate benefit of the people of Madagascar, and must therefore be made a priority. The effectiveness of protection programs is closely linked with integration of local populations to build a feeling of responsibility. Donors should monitor the protection program, assisting it if necessary, and they may even wish to base funding levels on the level of GOM commitment for environmental protection.

4.3 Pesticide Alternatives in Sensitive Areas

Farmers living in areas which have been designated as environmentally sensitive should receive training in IPM and the use of control methods which do not use chemical pesticides. These farmers should be encouraged to use traditional methods and should be informed as to how pesticides are dangerous to both humans and the environment. Farmers in such areas should be given individual attention, time to ask questions, and opportunity for discussion. ALS trainers should have a basic knowledge concerning food chains and the indirect effects of pesticides.

8.0 REFERENCES

A.I.D. 1989a. Locust/ Management, Operations Guidebook. Office of Federal Disaster Assistance, Agency for International Development, Washington, DC, USA.

A.I.D. 1989b. Implementation Plan for Government of Niger to Reduce Hazard of Surplus and Unusable Insecticides Acquired for Use in the Locust/ Control Program. Agency for International Development, Washington, DC.

Alomenu, H.S. 1989. Provisional Report on Pesticide Management in Francophone West Africa. Food & Agriculture Organization, Accra, Ghana, 58 pp.

Appleby, G., W. Settle and A. Showler. 1989. The Africa Emergency Locust/ Assistance Mid-term Evaluation, Tropical Research & Development, Inc., Gainesville, Florida, 146 pp.

Boberschmidt, L., S. Saari, J. Sassaman and L. Skinner. 1989. Pesticide Background Statements, Volume IV, Insecticides. Agriculture Handbook No. 685, US Forest Service, Washington, DC, USA, 578 pp.

Dynamac. 1988a. Results of the Mali Pesticide Testing Trial Against the Senegalese Grasshopper . Dynamac Corporation, Rockville, Maryland, USA, 111 pp +9 Appendices.

Dynamac. 1988b. Results of the Locust Pesticide Testing Trials in Sudan. Dynamac Corporation, Rockville, Maryland, USA, 84 pp + Appendices.

Jenkins, M.D. (ed.). 1987. Madagascar: An Environmental Profile. The IUCN Conservation Monitoring Centre, Cambridge, UK, 374 pp including Appendices.

Loken, E.R. 1988. Environmental Assessment Update - Morocco Locust Control Project Paper Supplement (Annex B), Agency for International Development, Rabat, Morocco.

Morgan, D. P. 1989. Recognition and Management of Pesticide Poisonings. 4th Edition. EPA-450/9-88-001. Environmental Protection Agency, Washington, DC, USA, 207 pp.

Potter, C.S., M.G. Rutanen-Whaley, H. Khoury and A. Messer. 1988. Draft Environmental Assessment of the Tunisia Locust Control Campaign. Agency for International Development, Tunis, Tunisia, 48 pp.

Randrianarijaona, Razafimbelo. 1983. Rapport National pour Madagascar.

Rutanen-Whaley, M. G., G. E. Cavin, R. W. Dyer, J. J. Drea, R. G. Hellyer and R. S. Stryker. 1988. Environmental Assessment of the Morocco Locust Control Project. Agency for International Development, Rabat, Morocco, 30 pp + Appendices.

Schwartz, T. K., M. F. Speers, G. P. Owens, J. B. Hannum, O. M. Ali, A. Gamal and S. El Bashir. 1988. Environmental Assessment of the Sudan Locust Control Project. Agency for International Development, Khartoum, Sudan, 62 pp.

Shaikh, A., E. Arnould, K. Christophersen, R. Hagen, J. Tabor, and P. Warshall. 1988. Opportunities for Sustained Development, Successful Natural Resources Management in the Sahel. Agency for International Development, Bureau for Africa, Sahel Office, Four Volumes.

Shannon, M. et al. 1987. Rangeland Cooperative Management Program, Final Environmental Impact Statement. Animal and Plant Health Inspection Service, US Department of Agriculture, Washington, DC, USA, 251 pp + Appendices.

Steedman, A. (ed.) 1988. Locust Handbook. 2nd edition. Overseas Development Natural Resources Institute, London, England, 180 pp.

TAMS. 1989. Locust and Control in Africa/Asia, A Programmatic Environmental Assessment. TAMS Consultants, Inc., Arlington, Virginia, USA, 305 pp + Appendices.

World Bank. 1988. Madagascar Environmental Action Plan. Preliminary Version, 77 pp + Appendices

APPENDIX A

LIST OF CONTACTS/PREPARERS

Government of Madagascar

Rakotobe Rabehevitra, Director of Crop Protection Service

Randriamanantena Benoit, Chief of Anti-Locust Service

Fong-Hong Lie, Anti-Locust Service, Southern Region

Randriamanantena Mahefa, Anti-Locust Service, Central Region

Tomboanarana, Cheif of Betioky Anti-Locust Station

Rakotonandrasana, Researcher at Betioky Anti-Locust Station

Rakotoasimbola, Ground-control operations at Betioky Station

Felicien, Air-control operations at Betioky Station

Razafimitsiry, Chief of Manja Anti-Locust Station

Ehlonogny, Manja Anti-Locust Station

USAID/Madagascar

George Carner, Director

John Thomas, Agricultural Development Officer

Ziva Razafintsalama, Agricultural Development Office

Carina Stover, Health Population and Nutrition Officer

CJ Rushin-Bell, Environmental Officer

Jean-Marc Andriamanantena, Environmental Specialist

USAID Washington

Bill Thomas, Entomologist

George Cavin, Entomologist

APPENDIX B

PEA for LOCUST AND MANAGEMENT
ANALYSIS OF PEA RECOMMENDATIONS

BASIC PRE-CONDITION OF PROGRAM

Recommendation 1. It is recommended that A.I.D. continue its involvement in Locust control. Operationally, the approach to be adopted should evolve toward one of Integrated Pest Management (IPM).

This recommendation should be applied in the context of the specific needs of Madagascar. USAID/Madagascar supports IPM in the management of locusts, as well as other insect pests.

INVENTORY AND MAPPING PROCEDURES

Recommendation 2. It is recommended that an inventory and mapping program be started to determine the extent and boundaries of environmentally fragile areas.

This recommendation is already part of the USAID/Madagascar portfolio and assistance effort. However, additional maps could include specific areas to be protected from locust control operations, some with a total ban on pesticides for locust control and some with a high priority for restricted use of pesticides.

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

Because of past poor management practices in Madagascar, stocks of pesticide have been allowed to accumulate and degrade. In addition, stored pesticides are not always handled carefully or tracked to insure correct use and disposal. Improvements in the system for managing pesticide stocks must be implemented to protect human health and the environment and to minimize chances of pesticide products becoming obsolete.

Recommendation 4. It is recommended that A.I.D. take an active role in assisting host countries in identifying alternate use or disposal of pesticide stocks.

A plan for disposal of the obsolete dieldrin stocks has been drafted by GTZ with the support of USAID/Madagascar and A.I.D. Washington. Additional activities should include the periodic testing of stored pesticide stocks to insure that the material is usable. Unwanted stocks in Madagascar should be disposed of only with technology that best fitsused, the local situation. High priority should be placed on minimizing the future accumulation of any unwanted pesticide.

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

USAID/Madagascar supports this recommendation with support from AID/W.

MITIGATION OF NON-TARGET PESTICIDE EFFECTS

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

Any future spray operations or pesticide donations for use in Madagascar should be accompanied by a requirement prohibiting use in some areas and limiting use in others and requiring appropriate buffer zones. The areas of total prohibition are designated wetlands, national parks, national forests, and fragile areas. Buffer zones and other reserves should restrict pesticide use, and encourage traditional and non-chemical methods. Villages, towns, cities, or any other human settlement will not be sprayed.

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

Pesticide recommendations in the PEA should be followed until research results indicate that more environmentally safe pesticides are available for use. Investigation of traditional and cultural methods of control are also strongly encouraged as a USAID/Madagascar activity. This SEA does not contain a list of pesticides because it accepts the pesticide selection in the PEA.

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

This recommendation should be implemented to some extent if possible, but may be difficult to fully implement in Madagascar, due to both the expense and a lack of supportive infrastructure. A program of research monitoring is important both as a basis for design of operational monitoring and as a means of establishing statistically verifiable base line data. In addition, periodic sampling observations of target and non-target mortality, population numbers, and behavior should be made at locations involved in pesticides use.

APPLICATION OF INSECTICIDES

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

A number of operational procedures should be followed to minimize the area to be sprayed. 1) Emphasis should be on an early and vigorous surveillance program, thus allowing early treatment operations and reducing the amount of pesticide used; 2) Crop protection operations should utilize intervention (economic) thresholds to the extent possible; 3) A program of identifying non-treatment areas and minimum treatment areas should be adopted; 4) Training of all decision-making individuals should emphasize the importance of restraint in use of pesticides; 5) Farmers and villagers should be included in training and subsequent survey and application operations.

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

The treatment program in Madagascar should emphasize early season ground application. However, during rainy season treatment operations, road conditions may necessitate the use of aircraft. In addition, there are areas of Madagascar which are impractical to access except by helicopter. The AID/W (Forest Service) Aerial Application Guidelines should be followed in any such operation.

Recommendation 11. It is recommended that, 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. However, medium sized aircraft may be needed in Madagascar to spray areas far from supportive infrastructure.

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

This SEA agrees with this recommendation. In addition, this SEA strongly supports both long- and short-term training to be integrated with USAID-provided technical assistance.

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

This SEA agrees with the recommendation and urges the GOM to give high priority to pesticide legislation and implementation of laws requiring a good clear label. It is suggested that the GOM follow the FAO pesticide label guidelines.

DISPOSAL OF PESTICIDES

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

A.I.D. Washington and the FAO are currently developing guidance on disposal programs for unwanted pesticides and empty containers. In addition, several pilot disposal projects are being implemented. USAID/Madagascar should follow such disposal guidance when available, and should continue to assist with proper pesticide management. Proper disposal of empty barrels is especially important.

PUBLIC HEALTH AWARENESS

Recommendation 15. A.I.D. should support the design, reproduction and presentation of public education materials on pesticide safety (e.g., TV, radio, posters, booklets). This would include such subjects as safely using pesticides, environmental awareness, pest management techniques of locusts, and the potential hazards of pesticides. The goal would be to enable policy makers and local populations to recognize and avoid potential health problems related to pesticide applications.

Collaboration between the ALS and other ministries should ensure the development of public and applicator education on pesticide safety, pesticide poisoning recognition, avoidance, and treatment. In addition to receiving information on general pesticide awareness, the public should be made aware of the need to protect environmentally sensitive areas from pesticide misuse. Radio is an extremely effective medium in this regard, and should be utilized to its fullest.

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

This SEA supports this recommendation and advocates inter-governmental collaboration in training programs.

Recommendation 17. It is recommended that each health center and dispensary located in an area where pesticides are used 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, and advocates collaboration between ALS and the Ministry of Health in appropriate implementation.

Recommendation 18. It is recommended that presently available tests for monitoring human exposure to pesticides should be implemented in the field. This includes measurement of cholinesterase levels in blood as a screening and indicator test for pesticide handlers and applicators.

This SEA supports the need to monitor the health of pesticide applicators and handlers during control operations. It is especially feasible to monitor blood cholinesterase in individuals working with organophosphate pesticides. This should be implemented on a regular basis with pesticide handlers and

applicators. In addition, this SEA favors behavioral monitoring for symptoms of pesticide exposure.

PESTICIDE FORMULATION AND MANAGEMENT

Recommendation 19. It is recommended that the specifications for A.I.D. purchase of locust insecticides be adapted for all insecticides.

This is an AID/W activity that should be implemented through a revision of A.I.D.'s Pest Management Guidelines, currently underway. No Madagascar-specific recommendation is included in this SEA as it is a central and regional activity.

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

This is an AID/W activity that should be implemented through a revision of A.I.D.'s Pest Management Guidelines. A.I.D. is working with the EPA Pesticide Disposal Workgroup to achieve state-of-the-art pesticide container specifications.

BIOLOGICAL CONTROL

Recommendation 21. It is recommended that Beauvaria and other biological agents such as plant extracts be field tested under African and Asian conditions in priority countries.

AID/W is currently supporting research on bio-pesticides in Africa. The need for carefully controlled studies in the area of biological control is stressed by this SEA. Other areas of research should be pursued, especially in regard to native populations of parasites, diseases and predators. USAID/Madagascar may support training and local research in this subject area.

TRAINING

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

This SEA supports that recommendation for Madagascar. The Locust Operations Handbook (A.I.D., 1989a) fills this need in part, as does the PEA and this SEA. Other materials include regional meetings and workshops, and short-term technical assistance.

Recommendation 23. It is recommended that local programs of training be instituted for pesticide storage management, environmental monitoring and public health (see Recommendation 16).

This SEA supports this recommendation, and recommends that the high priority be given to training on the safe and appropriate application of pesticides. Training can take the form of courses, as well having as individuals work with outside technical expertise. "Train the trainer" programs are especially effective in passing information with minimal expense.

Recommendation 24. It is recommended that when technical assistance teams are provided they be given short-term intensive technical training (including language if necessary) and some background in the use and availability of training aids.

This SEA supports that recommendation as an AID/W activity. The overall preference is to have technical assistance teams with the needed technical expertise and sufficient language fluency for the tasks to be performed.

ECONOMICS

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

This SEA supports this recommendation. Implementation in Madagascar might consist of an agricultural productivity analysis along with an annual agricultural database program. This should include a research study on crop loss analysis.

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

Due to the erratic nature of these insects, along with potential for social impact, a valid intervention (economic) threshold will require both the long-term collection of quantitative data, and research to determine the extent to which agricultural productivity is threatened. In this light, it is important that intervention decisions, especially those involving pesticides, are supported by valid professional judgement. This would ensure minimum pesticide procurement by limiting A.I.D. participation when a reasonable probability of substantial threat to crops does not exist.

ENVIRONMENTAL POLICY

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

This SEA supports that recommendation. AID/W and EPA are developing an assistance program to assist with pesticide regulations and policies, including human safety, environmental impact, and use, storage, and disposal. Implementation should include improvement of pesticide labeling, including clear precautionary statements, specific use directions, and appropriate instructions for disposal of empty containers. In addition, policy must include an environmental monitoring program, with results used in the planning of future pesticide use operations, as well as detection of possible misuse or unexpected adverse results.

PESTICIDE USE POLICY

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

This SEA supports that recommendation, and considers this to be a topic appropriate for GOM action. Such a pesticide inventory program, done in conjunction with good storage management, can prevent the build-up of obsolete stocks, and thereby reduce overall operations and storage costs.

PESTICIDE HANDBOOK

Recommendation 29. It is recommended the A.I.D. produce a regularly updated pesticide handbook for use by its staff.

This SEA supports that recommendation as an AID/W or REDSO activity. Among the relevant activities in this area are A.I.D. policies concerning pesticide use, efficacy and agricultural productivity, environmental impacts and health effects, and safety and mitigative measures. The Handbook should contain health, safety, and environmental assessments of pesticides that are likely to be used in Madagascar.

SUPPORT AND TRAINING

Recommendation 30. It is recommended that technical assistance, education and training, and equipment be provided crop protection services of host countries with a view to making the services eventually self-sustaining.

This SEA supports this recommendation, but only with a through analysis of actual needs, existing supportive infrastructure, and the ability of the ALS to manage a sustainable program.

STORAGE

Recommendation 31. It is recommended that more pesticide storage facilities be built. Until that occurs, emergency supplies should be pre-positioned in the United States.

This SEA supports this recommendation, and considers this a valid activity for Madagascar. Due the inadequate storage facilities that currently exist in Madagascar, support is for the Pesticide Bank concept. A through evaluation of storage facilities should be completed prior to project assistance.

FORECASTING

Recommendation 32. It is recommended that A.I.D. 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 AID/W or FAO activity.

PUBLIC HEALTH MONITORING AND STUDY

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

Although this is a valid activity for Madagascar, a lack of supportive infrastructure would require that such a research program be accomplished with outside expertise and facilities.

RESEARCH

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

This SEA supports this recommendation, including the search for other microbial pathogens of locust as a longer term priority.

Recommendation 35. It is recommended that applied research be carried out on the use of Plant extracts as an anti-feedant.

Several plant extracts in Madagascar are worth pursuing for bio-pesticide activity, and thus deserves additional field research. As additional funds are available, the most promising options should be pursued.

Recommendation 36. It is recommended that research be carried out to determine the best techniques for assessing the impacts of organophosphates used for locust and control in relation to the use of these and other chemicals for other pest control programs.

This SEA considers such comparative impact research an appropriate AID/W activity. A major international research effort has been conducted in Senegal on the ecotoxicological effects of locust insecticides. _

ENHANCING AND ACCELERATING IMPLEMENTATION

Recommendation 37. It is recommended that A.I.D., on the basis of the previous recommendations, develop a plan of action with practical procedures to provide guidance in locust control to missions in the field.

This SEA supports this recommendation. AID/W has a general plan of action that includes the development of Supplementary Environmental Assessments in the countries that are most critical for locust and control. These countries include Burkina Faso, Cameroon, Chad, Mali, Mauritania, Niger, Senegal, Sudan, and now Madagascar. These Supplementary EAs will, in turn, contain commitments for future actions. Country-specific plans of action will be developed to implement those commitments when needed. Such a plan for Madagascar has been developed by the ALS. The country-specific plans of action will be the backbone for guidance of locust/ control activities.

Recommendation 38. It is recommended that detailed guidelines be developed for A.I.D. to promote common approaches to locust and 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. Coordination must occur both at the AID/W level and the USAID/Madagascar level. In Madagascar, the ALS is not considered a coordinating body, and donors should discuss specific plans with each other. These efforts can and should be improved for the future.

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. Algérien 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
Cholpyrophos	# 37	September	1984
Diazinon	# 96.1	December	1988
Fenitrothion	# 142	July	1987
Malathion	# 152	January	1987
Lindane	# 73	September	1985

These are among the many Pesticide Fact Sheets issued by the U.S. Environmental Protection Agency, selected for relevance to locust and control. They summarize data known to EPA at the time of preparation of the Fact Sheet. They generally include information on acute and chronic toxicity to humans and other non-target organisms, handling precautions, and other instructions for use. They may be requested from:

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

AGENCY FOR INTERNATIONAL DEVELOPMENT
BUREAU FOR AFRICA
Office of Technical Resources

SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT (SEA)

FINAL COPY APPROVAL FORM

COUNTRY: MADAGASCAR

ACTION RECOMMENDED:

APPROVE: X
DISAPPROVE: _____
DATE: _____
Review Officer: _____ 9/22/92
William Thomas, AFR/TR/ANR/NR

DISCUSSION:

SEA is well done and ready for approval.

ACTION TAKEN:

Approval ✓ date 9/23/92

Disapproval _____ date _____

Bureau Environmental Officer: _____
John J. Gaudet, AFR/TR/ANR