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AFRICA EMERGENCY LOCUST/GRASSHOPPER ASSISTANCE (AELGA) MID-TERM EVALUATION

A Report Prepared for USAID/AFR

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EXECUTIVE SUMMARY

I. OVERVIEW

The African Emergency Locust/Grasshopper Assistance (AELGA) project is remarkably successful in achieving its first purpose, to combat the current locust outbreak. AELGA, in concert with OFDA, has made available to missions important assistance needed for plague control, e.g., technical assistance, commodities, and aerial spray services. To be sure, there have been problems, particularly in procurement. But AELGA and its collaborating agencies in USGS and USDA have succeeded nonetheless because of the dedication of their staffs and that of the USAID mission personnel--and despite the technical and administrative difficulties in project design and implementation.

AELGA has been less successful to date in achieving its second purpose, to effect those measures that will facilitate the longer-term control of such plagues. The reasons for this spotty success are several. Whenever disaster assistance and developmental aims are conjoined in a single project, the demands of emergency assistance will invariably override longer-term developmental activities unless special implementation mechanisms are already in place. Moreover, AELGA has never enjoyed the level of administrative and logistic support warranted by an undertaking of this complexity. Available resources have therefore tended to be channeled where most needed at the moment. Unfortunately, even those few resources devoted to some longer-term activities, particularly research, have been poorly used.

The small success of AELGA in achieving its longer-term aims is particularly disturbing because, without long-term institution building, any future outbreaks of locusts (or of grasshoppers) will have to be dealt with in the same costly manner as at present, namely, with aerial bombardment of pesticides. There is an alternative: institutional development. This alternative promises two major rewards. First, forecasting and surveillance (in other words, remote sensing with field verification) will enable ground operations earlier in the locust cycle, operations that are less costly economically, less complex institutionally, and more sound environmentally than hasty air operations. Second (and a direct consequence of the first pay-off) the disheartening frequency of emergency locust situations will decline dramatically as more potential plagues are nipped in the bud. In other words, locust infestations are a long-term problem, and while institutional development cannot eliminate the possibility of future outbreaks, it can conceivably reduce the number of outbreaks that become plagues.

To remedy this situation will require a number of coordinated actions, which are here organized as recommendation sets. First, implementation mechanisms must be established for emergency control operations. The recommendations in this first set constitute a template for emergency action, should the need arise again. Second, a number of short-term actions can be taken to assist USAID missions in their locust control activities. These actions include specific program assistance to individual missions, in-country training for health and CPS personnel, and information campaigns for the general public. Third, the evaluation team finds that while AELGA defined all of the appropriate research topics, much of the research has been inadequate and thus largely

unusable. In consequence, the longer-term research and development initiatives must be more closely supervised, with a technical panel reviewing at least initial proposals. Fourth, these recommendations have clear implications for project management, which is charged with assessing and implementing the recommendations. Because emergency assistance and longer-run development aims are not wholly compatible, it is recommended that an additional intern be hired to assist with project implementation. In that way, the project officer could focus on assistance to USAID missions, while the USDA/RSSA technical assistant could focus on the research initiatives. Fifth, the larger concern for locust control activities is whether they should be treated separately or as part of a larger program, be it crop protection or food security. Experience demonstrates that locust control activities are not sustained in the long run when they are dealt with as a separate activity. Thus, if long-term locust control is a fundamental aim of the project, future work will have to be funded through an umbrella project and must be directed toward developing a regional monitoring and control capability.

Each USAID mission will not find every recommendation below to be appropriate or relevant to its situation, but each should find several recommendations that, if implemented under the AELGA project, would facilitate its own actions in locust control. The reason for this variability is that the context for action differs appreciably in each host country and for each USAID mission. The type, extent and timing of locust and grasshopper infestations vary in each country. The distribution of population and of crops and rangeland is particular to each. The transport infrastructures vary from minimal to adequate. The institutional arrangements and capabilities of government agencies are all different. The USAID missions themselves all have larger or smaller staffs and budgets. And the roles of the donors, not to mention that of the host governments, exhibit significant variation. In fact, not only are the country situations quite variable, but the international, regional, and country system of locust control is even now undergoing significant modification. In consequence, a central project such as AELGA must possess the flexibility to deal with a wide range of present situations and future conditions.

In summary, the AELGA experience exemplifies the difficulty of conjoining short-term disaster assistance with longer-term developmental aims into a single project--and of attempting to provide disaster assistance within a developmental framework. This combination in the AELGA project reflects an institutional debate over which offices are responsible for combatting these repeated emergencies. This evaluation team, collectively and individually, believes that instituting appropriate implementation mechanisms for disaster assistance so that services and commodities can be called forward as needed could facilitate work on the required longer-term research and development activities in the region. In the meantime, the project must provide assistance to the USAID missions in the conduct of their locust control programs. The following recommendations detail the actions that can be undertaken in these regards.

II. RECOMMENDATION SET 1: A TEMPLATE FOR EMERGENCY CONTROL OPERATIONS

Emergency locust control operations succeed or fail on the efficacy of their logistics. The importance of an efficient logistics system increases as the amount of time for action decreases. A number of early indicators of the locust threat have already been missed by the time locusts are swarming across the continent. There is at that point no option to raising a small air force to spray the infestations. The whole undertaking very much resembles a military operation, and, just like a military operation, success or failure depends upon accurate reconnaissance, quick deployment of trained men and supplies, close coordination between headquarters and the field, precision treatment of sites, and no small bit of luck. For want of something as seemingly insignificant as a wrench or a nozzle, an army can lose a war and a government can lose a locust control operation.

At the outset, AELGA was intended to provide timely assistance in the medium term. The charge to AELGA was to implement procurement mechanisms that would enable timely response when an emergency broke out. Of course, a locust emergency already existed when the project was authorized, so project management had to institute immediately--and experiment with--implementation mechanisms from the beginning. Now that the locust emergency appears to be waning, the team makes the following commendations and recommendations based on this experience for the success of any future locust control campaigns.

General Point: Develop innovative implementation mechanisms that will enable project staff to respond quickly to emergency situations without diverting all time and attention to those episodes and thus losing sight of the longer-term developmental needs. These mechanisms include:

a. **Implement, either directly through the AELGA project or indirectly through the USDA RSSA, short-term (six to seven months) technical assistance in entomology to the missions that still lack this expertise.** Have available on a stand-by basis logistical assistance in the case an outbreak should occur. This sequencing of technical assistance has proved the most useful, for only an entomologist can make an informed call on a locust emergency, whereupon a logistician must intervene to organize the operations (Sections II B-F).

b. **Expand the pesticide bank to include other acceptable chemical and biological agents** besides the carbaryl and malathion that are presently available. Correct the administrative errors that impede the operation of this implementation mechanism, unless annual procurement decisions prove more viable, given the potential difficulties of "closing out" the bank account at the end of the project (Section I D-3c).

c. **Maintain a current file of firms that provide aerial spraying services and pesticide transport, with aircraft type, availability, and cost.** Inventory the

airstrip and storage facilities available in each country potentially vulnerable to locust infestations. In the event of a serious outbreak establish a regional umbrella contract for these services that would permit project management to call forth these services whenever and wherever they are needed within the region, perhaps along the model of the OFDA contracts for sets of countries. Avoid anticipatory contracts, however, because these are costly to pay off when the potential pestilence naturally disappates (Sections I A-2 and II).

d. Continue the present RSSA with USGS for the provision of greenness maps and for the provision of short-term technical assistance in map interpretation. This component of the project is very practical and field-oriented, and is one of the most widely appreciated activities of the AELGA project both in USAID missions and in host country government agencies. This activity complements the more sophisticated forecasting methods being developed by FAO. Continued support could be provided to AGHRYMET, which is developing a greenness map capability with USGS assistance under a USAID project (Section I D-3a).

e. **Continue the present RSSA with USDA for the provision of long- and short-term technical assistance to assist in locust survey and control procedures.** This would include: calibration of equipment and maintenance; use of greenness maps; radio reporting; maximizing use of rural population for reporting; map reading and interpretation; and aerial operations strategies. At the same time, abrogate the use of this RSSA for the procurement of commodities and other services. This use of the RSSA only displaces the problems from AFR/TR to USDA/OICD without greatly increasing the efficiency of response. (Section I D-3a; also see Recommendation 4-e, below.)

f. **Work with the appropriate African regional organizations, such as OCLALAV and CILSS,** for the conclusion of effective inter-state agreements on fly-over rights for the movement of survey aircraft, fly-over rights for cross-border locust control operations, the transport of pesticides and other agents among member states, and other such regional issues that have impeded locust control from time to time. Each agreement should focus on a particular ecological zone, as has been done, for example, with the Liptako-Gourma Commission and the Lake Chad member states (Section II A).

The implementation of these recommendations would greatly enhance the capability of AFR/TR AELGA project management to respond to emergency situations in a manner that would allow them to continue to work on longer term aims.

III. RECOMMENDATION SET 2: SHORT-TERM DEVELOPMENT ACTIONS-MISSION ASSISTANCE, TRAINING, AND PUBLIC EDUCATION

During emergency locust operations a number of problems and concerns are encountered that only become apparent with time. Emergency operations are extremely complex and strain the managerial capabilities of many host country agencies to the breaking point. The operations themselves have sequelae: bringing in barrels of insecticide for spray operations results in the accumulation of empty containers, which can become a health threat if used for other purposes. Too, there are major health concerns for the populace in general and for the pesticide handlers in particular. Often health personnel are unfamiliar with the symptoms of and antidotes for pesticide intoxication. And, finally, there are a number of ecological and health concerns about the cumulative, long-term consequences of repeated spraying for different agricultural and health purposes, such as locust control, other plant pest control, tsetse control, malaria eradication, or onchocerciasis control.

General Point: Provide whatever assistance USAID missions require in their locust control programs. In particular, develop a series of training courses pertinent to the consequences of locust control operations. These courses can be national or regional in scope, depending upon the level and number of trainees and the nature of the material being considered. (See Sections II B-F for details.)

AELGA assistance to USAID missions can greatly strengthen national locust control programs. The types of assistance possible will depend upon country needs, and so cover a wide range of possibilities: from technical assistance in entomology (Chad), through sponsorship of a conference on the health and environmental impacts of pesticide use (Mali), to construction of a pesticide warehouse and short-term training in pesticide selection for the head of the national CPS (Cape Verde). In each instance, the request for assistance should be generated by the mission, which is cognizant of the most pressing national needs for locust control. Nonetheless, the requests should be reviewed by the AELGA project officials to ensure consistency in the support offered. These small services will greatly further the USAID locust control program in the participating countries.

Training courses are more traditional institution building activities. **The topics for these training courses, which must emphasize field-level concerns, are:**

a. **Management of logistical operations**, for supervisors. This includes inventory and accounting systems, transport, strategic prepositioning of equipment and pesticides, as well as personnel management and systems analysis. Importantly, this work would strengthen the national crop protection services not only for locust control but for general pest management also.

b. **Health concerns in locust control operations**, for health personnel and locust control supervisors, as well as for pesticide handlers. Handlers often do not appreciate the dangers of pesticides, and the donated protective

clothing is often ill-suited for local conditions. Moreover, health personnel are often unfamiliar with the symptoms and treatment of pesticide poisoning. Thus two similar courses are envisioned: one for health personnel and CPS agents, and another for the pesticide handlers themselves, which would be given by their CPS supervisors.

c. **The strengthening of farmer brigades and of CPS terrestrial teams.** The aim here is to organize viable farmer brigades supervised and complemented by CPS teams. The questions here are how to organize and maintain viable farmer brigades, how to instruct the farmer brigades in accurate locust counts and reporting, and which mechanical and chemical techniques are most effective in locust eradication under specific conditions. These ground teams will naturally focus on crop protection, for the simple reasons that ground control requires labor which is available only in the populated, agricultural areas and that farmer cooperation is predicated upon their own self-interest. Villages in some areas already carry out their own operations (e.g., Chad, where farmers sweep locusts into ditches and ravines in order to bury them). Thus, the basic question is how to generalize these local forms of cooperation.

d. **Techniques for the proper storage and disposal of pesticides and their containers.** Moreover, qualified and unbiased technical assistance should be provided to evaluate the available methods for unusual pesticide stock disposal and for the renovation or destruction of empty drums. This training and technical assistance is necessary because emergency operations have given rise to very lax procedures for storage, use, and disposal.

e. **Cumulative effects of pesticide use on the environment, a regional conference for senior government personnel.**

These courses and conferences are recommended <u>in addition to</u> the courses now being delivered by AELGA on locust and grasshopper identification, ultra-low-volume aerial applications, and crop-loss assessment.

IV.RECOMMENDATION SET 3: LONG-TERM ACTIONS FOR LOCUST CONTROL--FORECASTING, INSTITUTION BUILDING, AND RESEARCH

The urgency of disaster situations overrides all other considerations. The compelling moral justification in disaster relief is to save as many lives as possible at whatever cost and in whatever way. This unarguable justification begins to lose its force as the same emergency recurs with unpredictable frequency. Moreover, the nature of the questions that will be asked about the operations then begins to shift. Is the disaster response the most effective reaction from an economic perspective? What are the longer-term ecological effects of a disaster response, such as blanket spraying? Are there any activities that could provide a longer lead time for more measured response? Might not institutional development in the regions and countries most threatened enable earlier and

more measured response? Each of these areas--economic, ecological, technical, institutional--is important and warrants attention.

One inescapable fact underlies longer-term locust control activities and studies: locust control can be implemented at any stage of the pest's life cycle, but the later one waits before intervening, the more costly the operation, the more complex the institutional arrangements, and the less ecologically sound the intervention strategies. This simple fact argues strongly that project development activities be directed towards those activities that allow earlier intervention. These activities include: strengthening crop protection services, training in egg pod surveys, egg pod destruction, locust population and infestation estimates, terrestrial pesticide applications; formation of farmer brigades; decentralized management systems with local decision-making authority. It is only with early, local and strategic intervention that locust outbreaks can be contained economically, ecologically, and institutionally. Other measures become necessary once the swarms begin to escape, and AELGA must be ready for this eventuality also. But most attention and resources should be directed toward preventative, rather than curative, actions.

The team therefore recommends that the project focus its efforts during the remaining life of the project on those longer-term institutional development aims that have the potential of assisting future locust control efforts and that complement on-going activities. This would involve the following activities.

a. **Work with the international organizations, in particular the FAO, that are developing a locust forecasting capability.** The funding levels for this work need not be elaborate, but the commitment to forecast development needs to be long-term. The most appropriate assistance would be a technical assistant, funded through the USDA RSSA or an IPA, to collaborate in the refinement of forecasting techniques (Section III E). At the same time, the team notes that operational control activities, training, and institutional development of crop protection services--all of which have been undertaken by the FAO with AELGA funding--are not effective uses of project funds. (See Recommendation 4-e, below.)

b. **Work through AFR/SWA with African regional organizations, such as OCLALAV, CILSS (and INSA), and AGHRYMET in, respectively: the development of training materials and the coordination among crop protection services (which are charged with locust survey and control); the coordination of logistical considerations (such as fly-over rights); and, the provision of meteorological information.** These regional organizations can all play an important role in the coordination and dissemination of information, and their roles, which are now being redefined, warrant further support. **While it may be necessary to continue to fund these activities through the FAO in the short term, that organization must be required to collaborate closely with the regional Sahelian agencies and a portion of the FAO grant monies could be earmarked for this purpose. Further, FAO must be required to develop a work plan for this institution building effort.**

The disbursement of funds to the FAO should be made contingent upon the effective implementation of this work plan.

c. **Coordinate the work being done by bilateral USAID missions in locust control and crop protection and facilitate the improvement of locust survey and control activities in national crop protection services, as requested by the concerned USAID missions.** (This coordination can be done either as at present at an annual USAID locust meeting or at the annual ADO conferences.)

d. **Develop the present economic cost/benefit analysis based on crop loss assessment for deciding when spraying operations are necessary.** This research must be done in close collaboration with national agricultural research institutes. Thus, unless the present arrangement with IPPC can immediately be made relevant to the aims of the AELGA project, it may be necessary to change contractors for the achievement of this work (Section III F).

e. **Continue the current work in alternative pesticide formulations and in alternative techniques for locust control. Institute a peer review process for the selection of research topics and the review of research methods.** This important work has not achieved its stated aims for a number of reasons (Sections III C and D). Nevertheless, these research endeavors are worthwhile and warrant continued support. It will be necessary, however, to exert much closer supervision over these activities and to require that the contractors work in close collaboration with the national research organizations.

e. **Institute an environmental monitoring (perhaps in conjunction with other monitoring efforts) and health safety program (e.g., application procedures, drum disposal methods).** In fact, given the high level of innovation among national crop protection services in these matters (e.g., protective clothing designed from local materials, traditional technologies of locust control), it would be worthwhile to sponsor a regional conference on such matters.

V. RECOMMENDATION SET 4: PROJECT MANAGERIAL CONSIDERATIONS

The scope of work for this AELGA project evaluation (Appendix 1) poses a number of managerial and programmatic questions. This section discusses these concerns and suggests viable propositions for their resolution.

a. **Retain AFR/TR as the project location within AID.** AELGA has led an orphan's life within the Agency, first being located in AFR/OEO, now in AFR/TR. Although it might be recommendable again to move the project, this time to AFR/OEC, each shift in bureaucratic location has entailed a temporary loss of staff, institutional memory, and efficiency. Whatever is

done with the project substantively, project management should remain in AFR/TR for the life of the project.

b. Take immediate steps to put in place the implementation mechanisms suggested in Recommendation Set 1, above. These actions will enable project management not only to respond more quickly and efficiently to any future emergency, but also allow them to define and track much more closely the research endeavors of the project.

c. **Design a longer-term development program along the lines suggested in Recommendation Sets 2 and 3.** Given the short time remaining in the project, it will be incumbent for the project to take advantage of activities occurring in one or another part of the region and to facilitate the dissemination of these approaches throughout the region. One major area of vital concern is the work being done by various crop protection services in the areas of health and the environment.

d. **Exert closer control over all research activities to ensure that the activities are relevant to AELGA needs, responsive to mission concerns, and integrated with host country agency activities.** The overextended contracting chain now used for some activities--e.g., the AFR/TR AELGA funding to S&T/AG for the CICP "buy-in" to pay Oregon State University for crop loss assessments to be used in the economic analyses--makes meaningful supervision almost impossible, with the result that the studies are unusable. Even directly managed research contracts--e.g., the Dynamac pesticide trials in Mali--have failed because of insufficient collaboration with national agencies by the contractor, among many other reasons. Yet because this work is fundamental to the overall aims of the AELGA project, project management must be closer at every step of the process and be more insistent on the timely delivery of reports. Finally, research reports, as well as TDY reports, must be pouched to all the interested USAID missions. (See Sections III C and D.)

e. **Cease immediately the use of agreements with USG and international agencies for emergency operational matters such as the procurement of services and commodities.** The use of the USDA RSSA and of the FAO grants to fund operational activities only displaces the logistical difficulties from USAID to those agencies, with no great gain in efficiency and a significant loss through greater costs. Indeed the use of grants to FAO for this purpose has proved not only less efficient for the procurement of commodities and some services, it has caused confusion in the roles of regional institutions and in some instances has complicated the activities of USAID missions working in the same countries. This uncoordinated duplication of efforts cannot be warranted under any circumstances. (See Section I C-6.)

f. In order to implement these recommendations and to exert closer technical control over the research endeavors, it is recommended that **an additional intern be funded through the USDA/OICD RSSA to assist the present project manager and long-term technical advisor.** In this way, the AELGA project manager will be better able to implement the mission-assistance recommendations, while the USDA/RSSA technical assistant will be better able to supervise the research program. Both the project manager and the technical advisor should collaborate on the development of training materials. (Section I C-4)

VI. MAJOR DESIGN CONSIDERATIONS IN LOCUST CONTROL PROGRAMS

Emergency locust control operations bring to the fore several considerations that are unusual in normal development activities. Ignoring these considerations--or attempting to deal with them in a conventional development framework--can cause more difficulties than it resolves. The team therefore takes this opportunity to raise these considerations for the design of future locust control programs.

Locust control is a long-term problem that respects no national boundaries. Locusts have plagued Africa since at least biblical times, and there is no technology to eliminate this pest once and for all. Rather, locust control depends upon early and efficacious action, upon continuous monitoring of breeding grounds and speedy action to eradicate the egg pod fields. If this is not done, swarms will continue to break out, necessitating costly aerial control operations over large areas. While these operations may in some measure cause the problem to go into remission for a while, there is no short-term solution to this "emergency."

The recent and present emphasis on locust control through the actions of national CPSs will, if successful, likely provide only a partial solution to the long-term problem. The CPS in each country will naturally emphasize agricultural areas. These are not the only places where locusts are found, however. The traditional breeding grounds of the desert locusts are often in remote and almost inaccessible areas. Thus a two-level program must be envisioned: national action through the CPS, focussed on agricultural areas; and, regional surveys for coordinated by an inter-state or international organization.

This evaluation team strongly supports institutional development of the national crop protection services for locust control, particularly in agricultural areas. The team believes that, if the locust problem abates in the near term, much project attention should be directed toward institutional development, which involves training in a wide range of topics, as well as some construction, particularly for safe pesticide storage areas. The team also supports the formation of farmer brigades for local action, and recommends strongly that AELGA begin to deal with this important aspect of locust control.

Nonetheless, a regional problem requires a regional response. Host country governments, no less than USAID missions in country, are reluctant to use scarce resources to resolve

a problem that, although bred in their territory, is most likely to fly away shortly. The rationale that swarms from breeding areas will simply vanish into neighboring state's domains is short-sighted, for unabated proliferation will return to haunt all nations at some point in the resurgence cycles. National efforts, therefore, should be conducted against traditional breeding grounds by concentrating well-planned terrestrial operations against infestations in crop areas and strategically utilizing aircraft to survey and treat breeding areas. Concerted collaboration among the concerned countries in regional fora can facilitate this work; hence the importance of OCLALAV (Organisation Commune de Lutte Antiacridienne et de Lutte Antiaviare), CILLS (and INSA), and AGRHYMET--as well as the interstate commissions and their agreements--in the future control of the locust problem. (Section I A-5a)

Regional programs are not viewed favorably at present. The emphasis in USAID on bilateral programs has evolved over time in response to a vast experience with an intricate set of interlocking problems in regional institutions. The simple fact is that many of these regional organizations do not function well. However, resorting to the assistance of international agencies such as the FAO for these activities only causes duplication of effort and confusion. Similarly, undertaking the operations oneself tends to undermine local capacity, even though that may be the only option available at the time. **The strategy must therefore be: to carry out these operations so as not to jeopardize locust control activities while at the same time building national and regional response capacities.**

Finally, **while the mission buy-in mechanism can work successfully for normal development activities, it is inappropriate for continued emergency disaster planning and implementation.** The mechanism can work once, if other projects are sacrificed to the compelling needs of emergency relief. But over time, missions find themselves without the funds necessary to finance such activities. And, in the end they risk vitiating their own development programs. The only viable course of action is to plan and implement early, efficient ground control operations within the normal AID program and for the central bureaus to make additional resources available in the instance that swarms break out and plague the area. (See Section I A-5b.)

VII. THE NEED FOR A FOLLOW-ON PROJECT

The AELGA project has a lifespan through September 1990. The longer term activities will require more time, and most likely, more resources to achieve the overall aim of food security. Inasmuch as the locust threat may now be presumed to be passing (only to reappear at some unknown future time), it would be well to consider now the possibilities for a long-term follow-on project. This concern leads the team to its final recommendation.

a. **Develop a follow-on umbrella crop protection or food security project that will continue the on-going activities of locust control and, at the same time, strengthen the crop protection agencies in the concerned countries so that they are better able to assist small producers in achieving the benefits from**

improved agriculture that are now accruing. In fact, this recommendation simply recognizes that AELGA has already been used as an umbrella project for funding such separate activities as famine early warning and rodent control research.

VIII. THE ORGANIZATION OF THIS REPORT

The following evaluation report documents the reasons for these recommendations in detail. The report is organized in strict accord with the original scope of work (Appendix 1). Thus, the report comprises responses to a series of specific questions. For this reason, the different recommendations are cross-referenced to the appropriate sections within the report, so that the reader can refer to those questions that most closely pertain to particular recommendations.

The reader might also wish to note that Section I deals with technical and administrative issues in project management. Section II sketches the international and regional locust control system and then presents a series of detailed case studies on the locust control program in five countries. And, Section III considers the environmental issues involved in--and the alternatives to--broadscale spraying of pesticides, and reviews the research activities of the project. In all, this evaluation is much more than a review of the AELGA project as an emergency and development activity. But then, the AELGA project can only be understood in the context of the very complex and changing situation of which it is a part.

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ACRONYMS

AELGA	African Emergency Locust/Grasshopper Assistance project
AFR/OEC	Office of Emergency Coordination, Africa Bureau, USAID
AFR/OEO	Office of Emergency Operations, Africa Bureau, USAID (superceded by AFR/OEC)
AFR/TR	Office of Technical Resources, Africa Bureau, USAID
AGRHYMET	Agro- Hydro- Meteorologie (a CILSS project)
AID/W	USAID, Washington, D.C.
APHIS	Animal and Plant Inspection Service, USDA
BHC	a pesticide
CICP	Consortium for International Crop Protection
CIDA	Canadian International Development Agency
CILSS	Comite Permanent Inter-Etats de Lutte contre la Secheresse dans le Sahel
CPS	Crop protection service
DDPV	a pesticide
DLTF	Desert Locust Task Force, OFDA, USAID
ECLO	Emergency Center for Locust Operations, FAO
EIA	Environmental impact statement
EPA	US Environmental Protection Agency
FAO	UN Food and Agriculture Organization
FAO/ECLO	see ECLO
ICIPE	International Center for Insect Physiology and Ecology, Nairobi
INSA	Institute du Sahel, CILSS

IPPC	International Plant Protection Center, Oregon State University, Corvallis, Oregon
L/G	Locust/grasshopper
GTZ	German
OCLALAV	Organisation Commune de Lutte Antiacridienne et de Lutte Antiaviaire
OFDA	Office of Foreign Disaster Assistance, USAID
OFDA/DLTF	see DLTF
OSE	Oedaleus senegalensis (Senegalese grasshopper)
OYB	Operating year budget
PEA	Programmatic Environmental Assessment
PRIFAS	Programme de recherches interdisciplinaire francais sur les acridiens du Sahel
RSSA	Resources Support Services Agreement
SOW	Scope of work
S&T/AGR	Office of Agriculture, Science and Technology Bureau, USAID
ULV	Ultra-low volume (aerial pesticide application)
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USDA/APHIS	see APHIS
USDA/OICD	Office of International Cooperation and Development, USDA
USG	US Government
USGS	US Geological Survey

I. TECHNICAL AND ADMINISTRATIVE PROJECT ISSUES

(SOW Section VI. Technical Issues)

A. DESIGN

1. Does the project meet the need it is designed to fulfill?

AELGA was originally designed with a clear emphasis on medium-term actions for the control of locust and grasshopper plagues. "Medium-term" was operationally defined in the project paper as longer than the initial three to six month period (the disaster period) when OFDA would intervene but shorter than 18 months to two years (the long-term development or institution-building period) when AFR bureau would have taken over the activities. Thus AELGA was designed to bridge the temporal gap between the mandates of the two bureaus. In part in recognition of the special nature of this project, AELGA was even located in a special, temporary office within Africa bureau. In the words of the PP (p.37): AELGA "is an AFR/OEO regional project: by definition it is an activity designed to meet the medium-term rehabilitation and recovery activities resulting from an emergency situation. At best, it will attempt to identify activities that may make sense in the long-term."

Nonetheless, the purpose of the project was two-fold. First, the project would provide the services and commodities necessary to combat the then-current problems of locust and grasshopper infestation in the afflicted African countries. The aim here was to help bring the problem back under control. Second, the project is to help establish improved management and control mechanisms that will keep this problem under control in the future. The aim here is to mitigate future infestations.

The first purpose is clear-cut: to create an emergency response capability in order to deal with repeated locust outbreaks. The inputs include technical assistance in entomology and logistics, as well as chemicals, equipment and services for spraying operations. The project has provided--and continues to provide--these services and commodities in limited amounts. The concern of this evaluation is largely with the timeliness of these contributions. (This concern arises because of the cumbersome implementation mechanisms required under the project. These matters are taken up in detail in Sections I A-2, I C-1, and I D-2.) The basic design problem is the attempt to provide emergency assistance through the normal developmental assistance mode, with all of the rules and regulations that are normally entailed therein.

The second purpose--to help establish improved management and control mechanisms for the mitigation of future plagues--lacks clear definition. The project paper repeatedly stresses the immediate, emergency component of the project: "the focus of the project is to provide emergency assistance to alleviate the threat posed by uncontrolled locusts and grasshoppers in Africa during the next three years, not institutional development, per

se" (PP:i). Or, again, this project "is designed to focus resources on an imminent emergency, and to control that problem as quickly as possible. **Although a number of the activities financed by the project will have host country institution building effects and create a capacity to deal with any future recurrences of the problem, the project's success must be evaluated in terms of the speed and efficiency with which it helps to identify and control the immediate crisis**" (PP:5; emphasis added). The project paper never specifies how these immediate emergency activities might contribute to the medium or longer-term control of locusts and grasshoppers. (At a minimum, crisis management reveals deficiencies and bottlenecks in the existing systems that require later correction.) And, the project paper specifies only one long-term activity: "developing systems for attaining better data with which to measure economic costs and benefits of various project activities...is a specified element of this project" (PP:38). No other longer-term development activities are so specified.

The emphasis on emergency assistance and the lack of clear definition of the longer-term aims give rise to three design problems that make it difficult to achieve the project's stated purposes. First, emergency assistance is to be provided within the usual developmental mode. This approach contains numerous pitfalls that cause untimely delivery of goods and services. While many of these problems have been corrected during the course of the project, the remaining obstacles to efficient emergency provision of goods and services must be eliminated. These matters are detailed in Section I A-2, and constitute the basis for Recommendation Set 1.

Second, the medium and longer-term developmental activities are mostly unspecified. As a result, a coherent and coordinated approach to the definition of an overall strategy for locust control that would reduce the need for massive aerial emergency operations is not yet evolving out of project activities. Nonetheless, many USAID field missions are independently developing a longer-range strategy based on institutional development for ground monitoring and control. AELGA can and should facilitate this process, paying particular attention to the immediate needs in the region as well as in the individual countries. These matters are taken up in detail in Sections I C-7, I C-8, and, most especially, II B-F.

Finally, and relatedly, conjoining clear-cut, short-term disaster assistance with ill-defined longer-run development aims creates an almost inevitable imbalance. Disaster assistance in response to many scattered outbreaks requires immediate and timely action. These circumstances require that the logistic details be resolved on a timely basis, for a delay at any step in the process could endanger the entire operation. In consequence, whenever locusts swarm, all or most attention must immediately be directed towards eradicating this threat. The longer-term institutional development activities suffer as a result. But these are precisely the activities that could provide longer lead times for locust alerts and thus enable more measured reaction. Locust forecasting, ground surveillance in key breeding areas during remission, local control operations wherever feasible, and effective regional cooperation all promise significant improvement in the current system of locust control. These longer-term initiatives are taken up in Sections II and III.

In sum, the project can fulfil its designated purposes if 1) appropriate implementation mechanisms for disaster assistance are put in place; and, 2) the longer-range aims are more clearly defined and developed into a coherent locust control strategy. As indicated above, this evaluation defines both feasible short-run implementation mechanisms and recommended longer-run development aims for the consideration of project management.

2. Does the project provide AID/W with an emergency response capability for long-term technical assistance; short-term technical assistance, pesticides, aircraft and commodities; and forecasting?

To one extent or another, each of the elements necessary for an emergency response capability is available to AID/W under the AELGA project. Long-term technical assistance has, generally, been superlative. Short-term technical assistance has also often been very good, though here the scarcity of qualified personnel has been more evident. Only a few of the recommended pesticides have been available, but supplies have been sufficient for most needs. Aircraft and commodities other than pesticides, by contrast, have posed a number of distinct problems. And, the forecasting information has generally been reliable, though further work is needed in this area. Each of these elements is discussed separately, below.

a. Long-term technical assistance

Long-term technical assistance directly available to AID/W has been provided through the USDA/OICD RSSA. This assistance has involved one entomologist for two years, another entomologist for four months (whereupon he joined OFDA/DLTF - Desert Locust Task Force), and one environmental specialist for six months.

The entomologists in particular have provided important advice and counsel on a wide range of issues from the outset of the project. The entomologists have guided discussion on the nature of the locust problem, the international and regional organization of locust control, country-specific requirements for locust control, and logistic problems for aerial and ground operations. Everyone concerned with AELGA in particular, and with locust control in general, agrees that this assistance has been invaluable in guiding the locust control effort.

The environmental specialist has been charged with supervising the programmatic environmental review and with developing the crop-loss assessment for cost-benefit analysis. These initiatives are considered in the respective sections of this report, III A-3 for the EAI and III-B6 for the economic analysis.

b. Short-term technical assistance

Short-term technical assistance available to AID/W mostly concerns consultants who have been provided to USAID field missions for specific tasks. Most of this assistance has been provided under the USDA/OICD RSSA. Qualified personnel from USGS have

provided some brief training in the interpretation of greenness maps. In addition, the long-term technical assistants based in AID/W have on occasion provided short-term assistance (Section I A-2a, above).

(Short-term technical advice has also been provided to USAID field missions and to host country governments through grants to the FAO, although this advice has not been directly available to AID/W. In one case an experienced entomologist was provided to a mission through a specific, small grant to the FAO. In other cases, long- and short-term entomological and operational advice were provided under the umbrella grant to the FAO. The uses and usefulness of these consultancies are considered in Section I C-6, which specifically considers the FAO grants.)

The USDA/OICD participation in short-term consultancy dates to 1988 when OICD sent three entomologists from APHIS to four countries to survey the locust situation and to make recommendations for action. Subsequently, USDA/OICD has provided three entomologists to USAID/Niger to conduct locust surveys and to coordinate the aerial spraying operations in the Agadez region, one entomologist to USAID/Mali to conduct locust surveys and supervise the crop protection program there (see Mali Case Study, Section II C), and a team of entomologists to USAID/Mauritania to conduct locust surveys. (This last team organized the myriad logistics for an important aerial spraying operation; see Mauritania Case Study, Section II E.) USDA/OICD has also provided an environmental specialist to USAID/Niger and USAID/Cape Verde to consider the problems of the disposal of excess pesticides and of pesticide containers (see Section II D for Niger and II F for Cape Verde). In addition, USDA/OICD staff have carried out technical consultancies for individual missions, e.g., USAID/Chad.

Overall, USDA/OICD has provided AELGA and AID/W with an important emergency response capability. And they have done so despite a real scarcity of qualified locust control experts: it has been unavoidably necessary to send consultants who are not fully prepared. Either the available consultant has the substantive experience but not the country knowledge or necessary language, or the individual has the requisite regional experience but not the specific entomological qualifications. These seeming handicaps aside, the individuals contracted have in each instance responded to the exigencies of the moment. This outcome clearly underscores the critical importance of personnel management in the selection of consultants for critical tasks.

USGS has also provided staff for in-country training in the interpretation of greenness maps. This staff is uniquely qualified--technically knowledgeable in the difficult art of interpreting remote sensing data, intimately familiar with the countries in the region, and fluent in the major languages spoken there. Thus, the USGS short courses have been tremendously helpful in guiding national staff through the intricacies of greenness map interpretation. This short-term assistance will, presumably, therefore have a lasting effect.

c. Pesticides

AELGA has devised and used two procurement mechanisms for the procurement of approved pesticides. While these mechanisms do provide an important emergency response capability, there have been difficulties in both approaches.

AELGA has provided approved pesticides to USAID/Mali and to USAID/Niger through the USDA/OICD RSSA and to USAID/Senegal through its own pesticide bank. USDA/OICD was able to respond quickly--within two weeks--to the mission requests for approved pesticides because it could buy into the already existing USDA/APHIS agreement with American Cyanamid. The problems for USDA/OICD arose over transport, not procurement. The project officer for the AELGA RSSA not only had to learn how to negotiate with a supplier, she had to obtain fly-over rights, lease an airplane, handle an unexpected delay in shipment when a forklift punctured a drum at Kennedy Airport, and coordinate with the missions involved. To her great credit, this project officer devoted two full weeks to these matters in order to expedite the shipment. Nevertheless, there were understandable difficulties due to inexperience. (For example, the flight number of the aircraft--rather than the identification number of the aircraft--was provided to USAID/Niger for it to obtain country clearance. There were also difficulties in unloading the barrels of pesticide because of the type of aircraft.) Under no circumstances whatsoever should these difficulties be attributed to the project officer concerned, who performed throughout with great dedication and persistence and who merits commendation for her role. Rather, these experiences demonstrate that USDA/OICD is little better prepared for emergency procurement than is AFR/TR. Contracting through USDA/OICD for the emergency procurement of pesticides or other acutely needed equipment only displaces the problems of procurement and transport. This approach does not--and cannot--resolve the fundamental problems. **It is therefore strongly recommended that AELGA immediately cease resorting to the USDA/OICD RSSA for the emergency procurement of pesticides and other commodities.**

AELGA has put in place a second procurement mechanism that provides an emergency procurement capability. This is the innovative concept of a pesticide bank. In theory, the project pre-purchases a specified quantity of approved pesticide from the manufacturer, who promises to provide up to that quantity on immediate call. In this way, the AELGA project officer can respond to a mission request for emergency procurement with a single call to the manufacturer. (This assumes of course that transport arrangements are also already in place; see Section A-2e, below.) The mission buys into the pesticide bank through AELGA, and AELGA then replenishes the bank with the funds from the mission buy-in.

None of this has worked out in the event. For reasons of administrative expediency, only one pesticide bank was established at the outset, and this only because that particular pesticide (malathion) was available through GSA. (Subsequently, a second bank was set up, for carbaryl.) In fact, this limitation has not had any particularly deleterious effects on the locust control program. However, because of administrative error, the documentation that was originally intended to establish a revolving pesticide fund actually allowed only for a one-time procurement. As it turned out, the

requirements of USAID/Senegal last year depleted the malathion "bank" entirely. While the administrative measures necessary to correct this error are now being made, the pesticide bank is--metaphorically and actually--bankrupt, so that it might be exceedingly difficult to respond to an outbreak at this time. As has happened so often in locust control, nature has cooperated with the campaign, and there have been no outbreaks that could have seriously strained the AELGA system.

Whether the pesticide banks are in fact established depends upon whether AELGA continues to support emergency locust control work. If AELGA terminates as scheduled in September 1990, the pesticide bank accounts will have to be closed out. This is already proving sufficiently difficult that the malathion bank has not been replenished and the carbaryl bank is in search of a need. (The carbaryl may be provided in dust form for use in bait tests.) In this situation, it may be better to make annual procurement decisions based on probable need. If on the other hand locust control work is to be continued, it would then be advisable to establish the banks, as originally envisioned.

The timeliness of response for pesticides has been affected not only by the chemicals available but also by the waiver requirements. There was last year just such a serious situation: USDA/OICD had, as requested, sent 20,000 liters of malathion to USAID/Niger. AELGA project management, however, had yet to obtain the required waiver of Regulation 16. USAID/Niger was therefore in the untenable position of having provided the Government of Niger (GON) pesticides necessary for locust control at the same time that it had to request that the GON not use those supplies until the regulatory waiver had been obtained. Fortunately, it was not necessary to use these stocks, but the problem posed was very real.

Finally, the pesticide testing program was intended to provide the research results necessary for determining which chemical agents should be used under specific conditions. These results, in concert with the environmental impact assessment, would provide the justification for the required waiver of Regulation 16 and also permit the establishment of several pesticide banks, each of which could be drawn upon in particular instances, thus tailoring the response to the particular conditions. The problems with this research (Section III C) have been sufficiently severe that none of this has proved possible.

In brief, AELGA has supplied limited quantities of pesticides to several missions. But the response time has not been particularly quick. There have been administrative delays in obtaining authorization for the use of the pesticides. And, the research activities that were supposed to provide the information necessary for environmentally sound decisions on pesticide use have not been successfully concluded. All of these problems have impeded a timely emergency response capability. Nonetheless, through one way or another, the locust threat in each country has been contained.

d. Aircraft and commodities

As in so much else, AELGA has provided aircraft for emergency spraying operations through various mechanisms and has encountered various problems in so doing. In

consequence, it is strongly recommended that the project set up, by analogy with the pesticide bank, a regional contract for aerial services. (The OFDA approach of contracting for aerial services to be provided in two or more countries provides relevant guidelines for implementing this mechanism.) By contrast, USAID missions have made few requests for the emergency procurement of commodities other than pesticides, and even these few have not be fulfilled on a timely basis, due in large part to the decision to follow normal procurement procedures during an emergency situation.

Aerial operations are as complex as they are expensive. Aircraft, fuel and pesticides of the correct formulation must all be available. Aerial spraying requires accurate ground or air reconnaissance to locate the swarms and careful ground coordination to pinpoint the targets. Calibration of droplet size becomes a critical matter for a successful operation. And, an hour of air time costs more than $1000 US. The delicacy, difficulty, and cost of these operations means that they are not the recommended approach for long-term locust control, except in remote or insecure breeding areas. Nonetheless they are effectively the only option available if, for whatever reasons, an outbreak occurs without warning or preparation.

AELGA has successfully provided an emergency response capability for aerial spraying through mission buy-ins or the umbrella FAO grant. In the first instance, USAID/Mauritania bought aerial spraying services, and USAID/Niger obtained important logistic services. In the latter instance, FAO provided operational assistance in Cape Verde and paid $75,000 US for fuel for USAID/Senegal. (This last example documents the curious case of AID/W paying overhead to the FAO to buy a commodity for the successful completion of a USAID field mission activity.) Overall, however, neither AELGA nor most USAID field missions has resorted to financing aerial operations; these have been the provenance of combined donor support, including OFDA.

The difficulties encountered when a bilateral USAID mission contracts directly for aerial spraying services are well illustrated by the experience of USAID/Chad. Faced with an extensive outbreak of desert locusts, the mission quickly contracted with an overseas firm for spraying services. Even so, the swarms had escaped by the time that the aircraft had arrived in country. The immediate problem was then in Mauritania. To move the aircraft to this area of operation required amending the original contract, which was done in near record time thanks to the hard work and good will of both the USAID and the contractor personnel involved. Nevertheless, because the contract was originally written with USAID/Chad, this mission found itself in the difficult situation of certifying financial documents for which it had no possibility of verifying the work done. As this case demonstrates, contracts for aerial spraying should be written for several countries. Which countries are combined into a single contract will depend on the classic patterns of locust migration. Contract monitoring would then be a central (or regional) responsibility carried out by the USAID missions actually involved. Importantly, this model has already been used by OFDA in its contract for aerial services. The model warrants replication in the instance that outbreaks occur in the future--but only in that instance since contracts are expensive to pay off if the service proves not to be necessary in the event.

Few commodities other than fuel and pesticide have been procured under the AELGA project. One notable example is the USAID/Cape Verde request for backpack sprayers. This emergency request became snarled in the normal procurement procedures and has only recently been fulfilled after a eight month lag. (See Section I C-1 for details.) Again, all applicable and necessary waivers must be obtained before emergency operations commence in order for the operation to be completed in a timely fashion.

Finally, procurement through the FAO grant has not shown any significant improvement over the AELGA record. Indeed, FAO procurement can be significantly tardier and, in several instances, has complicated the USAID field mission operation in minor ways. These concerns are taken up in Section I C-6 and in the Chad case study (Section II B).

e. Forecasting

AELGA has financed in part three types of forecasting activities: the USGS greenness maps, the PRIFAS predictive model, and the FAO/ECLO regional surveillance system. We here focus on the use of the USGS greenness maps. The inadequacies of the PRIFAS model are discussed in Section III B-5; the redundancies and confusions of the FAO/ECLO regional program are reviewed in Section I C-6. This section will present in conclusion only a few summary observations about these programs.

Through AELGA, the USGS has provided greenness maps to AID/W, various field missions, and host government agencies. The greenness maps are composed from satellite data on the density of vegetation in the area. The AELGA greenness maps have a resolution (pixel) of 1 km^2. The maps are compiled once every ten days. In the present system, USGS analyzes the incoming data immediately and cables the respective missions about significant changes in vegetation density within 24 hours. This cabled information relates to a mutually agreed upon system of coordinates. (In fact, several systems of coordinates are in use in the region, and they are not always compatible.) The maps themselves are sent by special courier within ten days. Because graphic information is much easier to use in-country than cabled tabular information, USGS is developing a system of illustrative maps that can be telefaxed to the missions within 24 hours of the reception of the raw data from NASA.

There have been several minor glitches in the USGS greenness mapping program. At the outset, USGS claimed that crop loss assessments could be made from the remote sensing data. This claim quickly proved to be unsustainable. Also, there have been delays in the delivery of the greenness maps due to customs regulations in particular countries. These are the fault of neither USGS nor of the courier service.

Apart from these very minor concerns, the USGS greenness mapping program is an unqualified success. The maps of vegetative density identify areas where sufficient rainfall has occurred to sustain enough green vegetation to support locust. The interpretation of these data very much remains an art. But USGS has a uniquely qualified staff who are able to discern anomalies, even if they cannot know why the anomaly has occurred. These careful interpretations allow the concerned government agencies to direct their surveillance teams to just those areas that are most vulnerable

to larvae or locust. In brief, the USGS greenness maps provide a timely (if somewhat late) indication of where locusts could constitute a threat. Of course, ground verification of these potential breeding and maturation areas remains an absolute necessity.

By contrast, the PRIFAS locust model, which is inadequately described in the literature, makes predictions about potential areas of infestation in the next 10 days based upon the known distribution of locusts in the current year. Reportedly, there is as yet no field verification of these predictions, and so no correction of the model. In consequence, PRIFAS predictions may identify some potential problem areas, but they also identify many areas that pose no problem. The small national CPSs are therefore forced to investigate many areas that in fact pose no threat, which constitutes an inefficient use of a scarce resource namely, reconnaissance teams. Although these deficiencies may be corrected in time, there is widespread skepticism among many entomologists about the reliability and utility of the PRIFAS model.

Under the AELGA umbrella grant to the FAO, ECLO set up a locust surveillance unit within, but separate from, OCLALAV. This operation provided important analyses of the locust situation throughout the region. But the redundancy with OCLALAV and the confusions in interpretation among the various reporting agencies very much undermined the utility of this operation. These concerns are detailed in Section I C-6.

In sum, AELGA financed several forecasting initiatives in order to help bring some order to a chaotic situation. In hindsight, it is now clear that the USGS greenness maps are a clear triumph, that the successful FAO/ECLO effort in coordinating locust control activities unwittingly undermined further the already weak capacity of regional organizations, and that the PRIFAS model has proved less than satisfactory.

f. Summary

Despite its many pitfalls, AELGA has provided important emergency assistance to USAID field missions. This assistance is widely recognized and greatly appreciated in the field, even as staff there rail against the many, petty bureaucratic snarls they have encountered. To facilitate emergency assistance in the future, the project should put in place a series of procurement contracts that will enable it to call forward services and commodities as required. These measures include: a pesticide bank for each approved and needed chemical agent; one or more regional contracts for aerial services, including transport of commodities; completion of the necessary waivers for emergency procurement; implementation of short-term technical assistance in entomology for those missions that still lack such expertise; and, possible implementation of a regional contract for logistical assistance, again to be provided in the case of a locust infestation to those mission that lack such expertise. These suggestions constitute Recommendation Set 1 of the Executive Summary.

3. Is it appropriate to address "recovery and rehabilitating aspects of locust/grasshopper outbreaks" in face of continuing plagues with respect to research and training?

"Recovery and rehabilitation" are concepts derived from disaster assistance. After the initial trauma--be it an earthquake, an avalanche, or a flood--homes must be rebuilt, medical and psychological needs taken care of, and the normal social and economic systems reconstituted. These are the usual and necessary activities of recovery and rehabilitation after an unexpected and unpredictable disaster.

The use of disaster-assistance terminology is understandable at the first outbreak of the locust plague, when it was seemingly was an unexpected, one-time event. This terminology is, however, ill-suited for a recurring (potential) disaster, such as continuing plagues. In this situation, recovery and rehabilitation properly glosses the provision of adequate foodstocks to devastated farmers. There is really no other "recovery or rehabilitation" operation necessary.

To consider research and training to be part of the recovery and rehabilitation work merely exemplifies the old wine-and-bottle conundrum. One can pour red wine into a bottle labelled for white wine. But that act does not change the fact that the wine is red, even if one insists on calling it white. One can call research and training "recovery and rehabilitation" activities, if that is the institutionally required format. But that labelling does not change the inherently long-term, institution-building nature of those endeavors. It may, however, make it more difficult to carry out those activities due to the artificially foreshortened timeframe of most recovery operations. (See Section B-7, below.)

4. Is the project mandate to address locusts/grasshoppers too restrictive?

The project mandate to address both locusts and grasshoppers is at once too general and too restrictive.

The project mandate is too general because locusts and grasshoppers pose very different problems. By definition (although the definitions themselves are somewhat loose), locusts are gregarious and migrate while grasshoppers are (relatively) stable. Locusts, which move from area to distant area, have few effective enemies other than nature itself. Grasshoppers, which tend to live in specific ecological zones, do fall prey to predators in their areas. In consequence, the strategy for locust control is very different from that from grasshopper control. The blanket spraying of pesticides may control a locust outbreak. The same strategy against grasshoppers may, however, exacerbate the problem because pesticides, by their very nature, kill not just the target pest but many insect predators of grasshoppers as well. Although there is a dearth of research on the matter, repeated spraying of grasshoppers almost certainly does not cause the problem to abate (the experience in certain cropping areas of Mali) and may exacerbate the situation if more predators than grasshoppers are killed (seemingly the case in Wyoming, where

blanket spraying operations were carried out, in contrast to Montana, where no control operations have been conducted).

Essentially, the rationale for combining grasshoppers and locusts is institutional. When the locust problem abates, as it will, the locust control service will have nothing to do--unless it undertakes grasshopper control operations during the long periods of locust remission. Although locusts and grasshoppers are apparently similar insects, this logic falters on the very different behavior of each pest. If grasshoppers are to be added to the mandate of the project, even though they are so different in behavior, then perhaps one should include other agricultural pests that may account for even more crop losses than either grasshoppers or locust.

This last point underscores the overly restrictive nature of the locust/grasshopper mandate. The fundamental rationale for locust control operations is crop protection or, in other words, basic food security. The problem in locust control is that surveillance must be sustained even during periods of remission in order to be prepared for the next, unpredictable onslaught. Interest in locust surveillance, however, tends to wane as the problem abates. In this situation, the only way to maintain surveillance despite waning interest and support is to ally the locust control to a larger crop protection program. The argument for this approach is taken up in Section II.

5a. Why design a "regional" project when Agency emphasis is on bilateral activities?

AELGA is designed as a regional project because, as has been said elsewhere, locusts do not carry passports.

In fact, however, AELGA operates very much like any central project that provides developmental assistance to USAID field missions. Most commodities, technical assistance, and other services are provided to a particular mission, either directly under AELGA or through a mission buy-in.

There are five specifically "regional" activities under AELGA--the USDA/OICD RSSAs, the pesticide banks, the FAO umbrella grant, training, and the various research activities. The first two of these activities--the USDA/OICD RSSAs and the pesticide banks--are regional activities in the sense that the contracts cover all of the countries in the region. In the event, however, the technical assistance or the pesticide is provided to particular missions. This model of a regional contract that allows bilateral assistance underlies all of the suggested implementation mechanisms in Recommendation Set 1.

Only the FAO umbrella grant and the research endeavors are truly regional. The FAO grant financed a regional surveillance and warning system; it is discussed in Section I C-6. The research activities, which contribute to the second goal of the AELGA project, could benefit all countries in the region in the long term; these activities are discussed in Sections II B through II H. In these instances, the information needs and the

benefits, respectively, transcend national boundaries and require a specifically regional approach.

5b. Did the "buy-in" provision help or hinder attainment of objectives?

The "buy-in" provision provided USAID field missions with a legal mechanism for carrying out locust control operations. By buying into AELGA, missions obtained the authorization to conduct locust control operations, even though they did not then have such a project themselves. Were they to have tried to design such a project and have it approved, they would likely have found themselves confronted by a massive problem and no authority to tackle it. In this sense, then, the buy-in provision facilitated attainment of the immediate objective of combatting the current locust outbreak.

In general, the buy-in mechanism is an important alternative to project development for most longer-term assistance work. A central project with the buy-in provision allows a field mission to take advantage of some activity or set of activities that complements its own portfolio but that are not specifically mandated in that portfolio. By buying into the central project, the mission can obtain the needed service or commodity without having to design a new project or amend an existing one. Since these buy-ins take place in the context of normal development assistance, the mission can usually foresee its needs for the coming year, and program for the activity within the regular budgetary cycle.

Locust control operations are a different and special case, where the buy-in mechanism can become a disincentive when used repeatedly for disaster assistance. When a locust disaster first strikes, the situation is desperate and the problem immediate. A mission will in this situation take funds earmarked in its OYB for specific development activities and reobligate those funds for disaster assistance through an AELGA buy-in. Should the disaster reoccur, however, the mission risks sacrificing its development program to disaster assistance if it again reallocates funds from development projects to locust control. The problem is that there is only limited financial flexibility in any development project. To cut too far into a project's funding runs the risk of disabling the project. This problem is exacerbated by the administrative regulation that the reallocation of funds from certain activities--health, population, environment--can only be approved by AID/W. Thus the exigencies of locust control often mean that projects in the "unprotected" sectors will suffer disproportionate cuts. In time, development assistance is sacrificed to disaster assistance.

This contradiction has already become severe in the smaller missions--USAID/Cape Verde, USAID/Mauritania--whose small portfolios do not have enough flexibility for repeated emergency reallocations of funds. (These missions face the additional problem that their deobligations and reobligations are handled by REDSO/W in Abidjan because the missions are too small to warrant a comptroller. There is strong possibility for confusion in communication and delay in execution, as the different parties attempt to understand what needs doing and why.) It is strongly suggested that AELGA reserve a small percentage of its funds in order to assist these missions to carry out the extraordinary long-term locust control activities. Nonetheless, it must be recognized that

all missions, regardless of size, will feel the consequences of repeated use of the buy-in mechanism for disaster assistance.

6. What is the relationship between the project and the recently created Desert Locust Task Force?

The Desert Locust Task Force (DLTF) and the AELGA project have distinct, but overlapping, purposes.

The goal of the Desert Loccust Task Force is "to assist host countries in reducing locust population to the point of remission." More specifically, the DLTF is mandated to coordinate the U.S. response during the desert locust crisis. This means that the DLTF "has responsibility for coordinating all emergency and short-term Desert Locust activities, whether or not disaster declarations have been made" (Information Memorandum to the Administrator, from Julia V. Taft, OFDA/D, June 13, 1988;p.2). The DLTF is charged with work on locusts exclusively and only during the period of "OFDA's emergency role (perhaps...1 year)." A senior-level panel is to review the locust emergency situation quarterly and assess the need to continue the Desert Locust Task Force (p.6). In brief, DLTF is charged with the immediate operational aspects of locust control.

By contrast, the purposes of the AELGA project are two-fold: 1) "to treat the recovery and rehabilitation aspects of problems created by locusts and grasshopper pests," and 2) to "help to establish improved management and control mechanisms." In other words, AELGA is charged in the project paper with both the aftermath of locust infestations and the longer-term developmental activities necessary for successful future control.

This ideal division of responsibility is reflected in the types of activity each unit will carry out. OFDA/DLTF will coordinate the USG effort and handle operational matters; AFR Bureau "will continue its current projects...and ...the development of appropriate mid- and long-term programs" (Memo, June 13, 1988;p.3). More specifically, DLTF will: coordinate policy; conduct of locust surveys and their assessments; provide technical assistance as needed; procure pesticides, aerial services, and other commodities; monitor control efforts; coordinate USG participation; chair interagency meetings; coordinate with other donors; attend international conferences; have budgetary responsibility for augmented emergency aid; develop guidelines for pesticide application. Meanwhile, the AELGA project will: establish pesticide banks; test chemical pesticides; test biological control technologies; carry out programmatic environmental assessments; perform economic crop loss assessments; devise training manuals; and support national CPSs.

Even this ideal division of responsibility contains some overlap and duplication. Both DLTF and AELGA will provide pesticides and both will test or develop guidelines for pesticide use. Further, OFDA will publish a grasshopper/locust operations manual that could readily be considered a training manual in support of national crop protection services. In fact, the extent of the overlap is even greater: both perform locust surveys and carry out locust assessments (albeit DLTF does this on a regional basis while AELGA, with the USAID missions, does this more on a country basis); both provide

entomological and logistic technical assistance; both provide aircraft, fuel, and other commodities (although OFDA pays for much more of these expenses); and both have budgetary responsibility for the unexpectedly greater needs of emergency aid.

In operation, then, OFDA has responsibility for coordinating the overall, regional locust control effort and for most operational matters for anti-locust response. But AELGA has in the past--and in principle could in the future--provide at least some of this same operational support. Moreover, AELGA is charged with more of the longer-term developmental activities

Thus, the responsibilities of the DLTF and of the AELGA project are clear in principle but overlap in fact. This overlap has had two consequences. First, USAID field missions are not always sure just what services are available under the AELGA project. Second, because OFDA/DLTF is responsible for overall coordination of the USG effort, DLTF personnel have given instructions to AELGA subcontractors without first clearing the request through AELGA project management, who are directly responsible for disbursement of those project funds. (These problems of coordination are considered in Section I C-3.) Importantly, neither problem has caused irremedial harm to any locust control program. Nonetheless, both the unclear mandate of AELGA in emergency operations and the overreaching mandate of DLTF in coordinating those operations warrant reconsideration.

7. Is it realistic to limit the life of project to three years?

Whether the three-year life of project is a realistic limit depends upon the purpose of the project. If the major aim of the project is "to treat the recovery and rehabilitation aspects of problems created by locusts and grasshoppers" and if these problems abate within three years, then, this life of project is realistic. If, however, as the project paper states, a second purpose of the AELGA project is to "help to establish improved management and control mechanisms," then the three year limitation seems less realistic. Even this is arguable, for the stated purpose is "to help to establish" rather than the more concrete "to establish." It could, for example, be argued that locust control campaigns reveal important deficiencies in national crop protection services, and that these revelations are a primordial necessity "to help to establish improved management and control systems."

The adequacy of the present life of project can also be considered in terms of the magnitude of outputs expected under the project. AELGA outputs include: research technologies, trained Africans, better early warning systems, improved pest management, a controlled pest situation, and pest threat elimination. The objectively verifiable indicators for these outputs are: first, operating systems for pest management and warning; second, viral diseases available to treat 50 percent of normal infestations; and, third, 300 Sahelians formally trained, and an additional 1500 trained informally.

These verifiable outputs have only been achieved in small part at the mid-way point in the present timeframe of the project. As for the first indicator, the operating system for

pest warning implemented under the FAO umbrella grant is scheduled to be handed over to OCLALAV this June, when the FAO grant expires. OCLALAV, however, has no funds to continue this operation. By contrast, the pest management systems are the responsibility of the national crop protection services. The national CPSs have gained a tremendous experience in carrying out the locust control operations. But many still have far to go, and all need equipment and training if they are to carry out this function in the future. (This matter is taken up in detail in Section I C-6 and in Section II.) As for the second indicator, the research on viral diseases has suffered various setbacks, and for most intents and purposes is only going to get underway in the last year of the project. (These difficulties are considered in Section III B, C, and D.) As for the third indicator, relatively few Sahelians have been trained to date either formally or informally under AELGA. Although the training program got off to an admirable start in PY 1, most training activities were suspended in PY 2 due to the exigencies of the widespread control campaign. Additional courses are now scheduled for the second half of the project, but is unlikely that the presently scheduled courses will reach the numbers of individuals originally intended.

In sum, it would appear that the present life of project will have to be extended for the project to achieve its original expectations on the level or magnitude of outputs to be accomplished under the project. At the same time, if the project is extended, it will be necessary to reconsider each of the intended outputs. It will be necessary to define a clear concept of the operating systems for pest warning and management at all levels. It will be necessary to exert very strict controls on the contractors carrying out the pesticide and insect disease research. And, it will be necessary to develop new training courses that deal with additional matters related to locust control that have become apparent over time, such as health and safety factors, as well as the long-term environmental consequences.

8. How realistic are the approved verifiable indicators in measuring attainment of project goals and purpose?

The objectively verifiable indicators of the program or sector goal are: reductions in food imports; fewer cases of malnutrition; lower market food prices due to increased availabilities of locally produced foods. The conditions indicating achievement of the project purposes are: pest levels back to normal; better early warning systems in place; African technicians trained in current control methods; and, no anticipation of up-coming emergency infestations. (This selection of indicators is copied in its entirety from the logfame in Appendix B of the Project Paper.)

The indicators of success in the sector goal all concern national food production. The sector goal of basic food security is logical. If national food stocks are protected (through locust control), then food prices, malnutrition and food imports should all decline. In the context of locust control, however, this logic is tenable only under the highly unrealistic assumption that locusts are the major cause of crop loss. In fact, locusts are only one of many pests, and in many areas at most times not even a major pest. Moreover, post-harvest losses often account for a significant portion of the spoiled

production. Thus, successful achievement of the program goal might result in only a marginal increase in the national food production. This is true even though for an individual farmer a successful locust campaign could mean the difference between total devastation and a bountiful harvest.

The indicators of success for the project purposes are, for the most part, more realistic. Certainly, the implementation of better early warning systems is a sine qua non for successful (and early) locust control. And, too, better operational systems will depend upon trained Africans for their continued success. However, there is in reality no "normal" level of pest infestation. The locust problem has come and gone ever since Biblical times. It is as yet impossible to discern whether abatement of an outbreak is due to human intervention, to nature (which blows the insects out to sea), or to natural remission which is brought about by environmental conditions. For this reason, the anticipation of no up-coming emergency infestations is a happy situation, but no indicator of project success.

The project goal and purpose must, in sum, be redefined specifically in terms of the locust problem. The program goal remains: "improved nutritional status of Africans by reduction of locust/grasshopper plague-induced famine." The measure of goal achievement must, therefore, specify locust operations. The measure is the amount and value of present (and future) crops at vulnerable stages of the production cycle, and of livestock on rangeland, that were saved by locust control operations. In fact, the data necessary for this assessment are not available from government records. This is a major concern for--and will be a major undertaking of--the crop loss assessment work to be done for the economic cost-benefit analyses (Section II B-6).

The indicators of success in achieving the project's purposes also require respecification. Locusts are not a one-time disaster, which necessitates recovery and rehabilitation activities. Locusts are a continuing problem. The key to locust control, therefore, is early warning. The relevant indicator of project success is whether a higher percentage of hopper bands and swarms are identified and destroyed earlier in their life cycle. Importantly, this strategy of locust control is not identical to the strategy for crop protection that is expressed in the program goal statement. Effective, early locust control often takes place in remote, unpopulated areas of difficult access, quite far from the major agricultural areas of the Sahelian countries. How to integrate locust control with the mandate of national crop protection services is a point taken up later on, in Sections II A - II F, where the current and project locust control programs are reviewed.

B. BUDGET

1. Are budget allocations listed in the project adequate for the major items?

The budget allocations in the project paper for disaster assistance and development have proved adequate, even though the amounts obligated have been consistently less than that originally allocated. The major concern is the use of the monies available.

Emergency assistance has provided services and commodities necessary for locust control. Many of the funds expended to date on research have not repaid the initial investment (Section III); this situation requires immediate rectification.

The original budget in the project paper is presented in Table 1. Slightly less than three fifths (58%) of the total budget were allocated to emergency assistance, and just more than two-fifths (42%) to development assistance. Over time, a quarter of the budget was available in PY 2; half in PY 2; and a quarter in PY 3. The relative allocation within categories was similar over time.

TABLE 1

AELGA BUDGETING BY CATEGORY
($000)

EMERGENCY ASSISTANCE		DEVELOPMENT ASSISTANCE	
Chemicals	3,750	Research	3,925
Equipment/Leases	3,000	Training	1,300
Technical Assist.	1,900	Institutional Support	1,125
	8,650		6,350

The actual amounts obligated since the beginning of the project are given in Table 2. The amounts actually spent do not differ greatly from what was originally envisioned. The major change is that institutional support was intended at the outset to support the East Africa locust control organization, DELCO; these monies were later reprogrammed for other purposes, including the FAO umbrella grant.

TABLE 2
AELGA OBLIGATIONS, BY BUDGET CATEGORY
($000)

	FY 87* (PY1)	FY 88 (PY2)	FY 89** (PY3)
DISASTER ASSISTANCE			
Greenness maps	300	200	0 (600)
Emergency response	990	3,868	100 (2,450)
Commodities	2,056		
Short-term TA	157	317	45 (200)
Subtotal	1,447	6,441	145 (3,050)
DEVELOPMENT ASSISTANCE			
Long-term TA	151	298	45 (200)
Training	369	0	520 (185)
Research	1,477	1,461	927 (1,050)
Other	13	50	160 (150)
Subtotal	2,010	1,809	1,652 (1,970)

* Excluding the sums allocated to the FEWS project.
** Excluding the sums allocated for rodent control. Also, the sums in parentheses are additional monies that would be requested if need and occasion arose.

2. **Is the project budget sufficient to encourage and augment missions and host country budgets?**

The AELGA project paper makes a strong assumption that project activities will demonstrate the importance of continued work in locust control. "The results obtained within the life of the project will either develop a definitive solution, or be impressive enough to prompt the host country or other donors to continue them. Further, it is anticipated that some methodologies developed during project implementation will be adapted for use against other pest problems" (p. 31).

USG participation in locust control is greatly appreciated throughout the Sahel. Government officials in each of the countries visited made it a point to express their gratitude for USG assistance. They typically mentioned not only the operations that were carried out by USAID missions in specific regions but also the contributions in equipment, communications, and coordination received from each USAID mission and from the AELGA project.

Appreciation and gratitude do not translate easily into larger budgetary support. Most governments in the Sahel are under strict financial constraints. It is difficult, if not impossible, to reallocate scarce funds to new initiatives when programs and staff are being reduced in other sectors. USAID missions face similar constraints, albeit for different reasons. Having already allocated a significant share of their resources for locust control, they find it difficult to increase that allocation for additional locust activities. This situation is more severe in the smaller missions, which have smaller budgets and thus less flexibility in programming.

It is recommended that AELGA reprogram some of its emergency funds to provide small, but critical assistance to the USAID missions. Each mission has different requirements: Chad needs short-term technical assistance in entomology to monitor locust breeding areas; Mali wants to sponsor a training seminar on the health consequences of pesticide handling; Mauritania can use assistance with some equipment purchases (e.g., fax machines); Cape Verde has offered to upgrade the central warehouse for pesticide storage. Each of these endeavors is important in the context of the on-going country program. Facilitating these and similar efforts will enable AELGA, through the USAID field missions, to further locust control work. Of course, from the perspective of the central AELGA project, these separate little contributions do not themselves add up to a coherent program. But here, it must be remembered that AELGA is an assistance project intended to make available in-country those resources that will further the locust control program.

3. **Does the current project budget provide adequate incentives for USAIDs and host countries to commit greater levels of their own resources for the locust/grasshopper program in a timely manner?**

The current budget can provide adequate incentives to USAIDs and host country governments to increase their funding of locust programs, if, as recommended, some

emergency funds are reallocated to small projects that contribute significantly to locust control in each country.

The notion here is that in providing needed resources to the host country government, the USAID mission can leverage the contribution for other, related purposes. Again, however, it must be remembered that the financial situation of most Sahelian countries does not permit large increases for locust control. The problem, then, is to define and facilitate the most needed activities.

C. MANAGEMENT

1. Are the project implementation arrangements adequate from a technical and managerial perspective?

The project implementation arrangements are technically and managerially adequate for the longer-term development activities but not for the shorter-term disaster assistance. In fact, the inherent contradiction in AELGA now that the project is located in AFR/TR is that disaster assistance is to be carried out within the framework of a conventional development project. This means that all the usual procurement and other regulations must be satisfied before commodities or services can be obtained. This requirement has not only caused numerous delays in the delivery of goods and services, it has encumbered much project management time, which could have been spent in other ways.

The essential point is that if AELGA is to conjoin both disaster assistance and development activities within the same project, then project management must institute those emergency procurement mechanisms that will enable it to call forward goods and services when needed.

The pesticide bank represents one such innovative implementation mechanism. The original intention here was for the AELGA project to purchase a quantity of several pesticides. In the case of an emergency, the USAID mission could call the AELGA project officer to request a quantity of a particular pesticide. The mission would obligate a sum of money to the project for the pesticide purchase. And, the project officer would call the manufacturer to have that quantity of the pesticide sent to the mission making the request.

In fact, the bank idea was never implemented. What happened is that AELGA pre-purchased a quantity of one chemical, which was provided to several missions. When the pesticide account was depleted, the project reinitiated the usual procurement procedures in order to restock the "bank." In other words, instead of creating a revolving fund (which would have created difficulties in closing out the project), pesticide procurement was handled on a separate, annual basis. This arrangement has made it possible to tailor purchases more closely to probable need. Moreover, these pesticide accounts were established only for two chemicals--malathion and carbaryl--rather than for the eight

originally contemplated. This deficiency has caused little difficulty because the greatest need has been for aerial spraying, for which malathion is well suited.

Similar arrangements must be made for each of the other goods and services required in an emergency operation. Ideally, a regional contract for aerial spraying services could be put in place. The problem here, however, is that the contract would have to be paid off whether or not an emergency occurs. To avoid such unneeded costs, it would be better to maintain a file of companies that provide aerial spraying services abroad, including types of aircraft, costs, response times, and the like. Then, in the case of an emergency, these companies could be contracted, as has been done under AELGA already. While the contract will be written for the country where the emergency is occurring, it should also contain a clause that will allow the planes to be diverted to other, neighboring countries should the infestation dissipate before the operation gets underway. This type of "escape clause" would avoid the sorts of legal and administrative difficulties that arose when the planes contracted for Chad had to be diverted to Mauritania.

Similarly, AELGA and its subcontractors, such as USDA/OICD, should maintain their files of entomological and logistics experts who are available on short notice. An ideal in-country locust warning and control system entails one short-term (six of seven months per year) entomologist who oversees locust monitoring for USAID. If and when the entomologist makes an emergency call, a logistics expert should be sent immediately (not on the plane with the pesticides) to coordinate the operation. Admittedly, there is only a small pool of qualified and available experts in these fields--particularly, entomology--so that sending new personnel will be unavoidable in the event. A current file of qualified experts would, however, greatly facilitate this staffing activity.

The implementation of these recommendations would greatly enhance the capability of AFR/TR AELGA project management to respond to emergency situations in a manner that would allow them to continue to work on longer-term aims.

The developmental initiatives under the AELGA project--research, training, and institutional support--have suffered precisely because a locust emergency broke out last year and the necessary implementation mechanisms were not in place. Training, for example, was cancelled last year, even though it had been gotten underway in PY 1, which was fully a year in advance of the project paper schedule. And, as has been mentioned, the institutional support has been reprogrammed for other uses.

The research activities pose a very different consideration. Essentially, these activities are necessary and contribute to the achievement of the overall aim of future locust control programs. Unfortunately, the actual research activities have not been very successful. In part, this is due to an overextended contracting chain--with AELGA contracting through S&T/AGR for CICP to have work done by Oregon State University. The number of responsible parties in this chain diffuses authority and leads to unclear definition of project aims. Even where the contracting chain is short (e.g., the Dynamac contract for pesticide trials), however, the research has not been carried out satisfactorily. In part, this is due to technical experts unfamiliar with the host countries carrying out

overly complex research designs without close national collaboration. The upshot is that unreliable or unclear research results lead to long delays in the presentation of reports, which, of course, hampers the incorporation of these findings into the overall program. Much closer supervision of research activities and much more stringent reporting requirements on the part of contractors are clearly called for. (A remedy to this situation--a research intern under the USDA/OICD RSSA--is discussed in Section I C-4, below.)

2. Has the effectiveness of the AELGA project been impacted by the creation and dissolution of OEO and subsequent creation of the Desert Locust Task Force?

The effectiveness of the AELGA was impeded by the dissolution of AFR/OEO and the transfer of the project to AFR/TR because of a break in administrative continuity. The subsequent creation of the Desert Locust Task Force, which has much the same mandate as AELGA, is less a question of impact than of coordination.

AELGA was originally designed to bridge the gap between the OFDA mandate for emergency assistance (up to 180 days in most cases) and the AFR/TR mandate for long-term developmental assistance (anything beyond 18 to 24 months). The project was therefore located in the newly created, but temporary, Office of Emergency Operations (AFR/OEO).

The roles and responsibilities of each office were clear at the outset. The Locust/Grasshopper Strategy Paper (p.6) details the different, overlapping responsibilities of OFDA for short-term assistance, AFR/OEO for medium-term assistance, and AFR/TR for long-term assistance. All three offices might provide assessment teams, equipment, and aerial spray services for locust operations. But only OFDA or AFR/OEO could provide emergency pesticides and equipment. And only AFR/TR or AFR/OEO would provide pesticide testing and guidelines, long-term training, environmental research and assessments, and institution building. Clearly, AFR/OEO thus provided an important institutional bridge between the very distinct temporal mandates of the two bureaus concerned, OFDA and AFR.

This institutional arrangement was soon changed. AFR/OEO was disbanded after six months of operation, in October 1987. Although a new office of emergency coordination (AFR/OEC) was created, management responsibilities for the AELGA project were transferred to AFR/TR, which has since managed the project. More recently, in July 1988, OFDA created the Desert Locust Task Force, which has much the same mandate as AELGA, albeit with less emphasis on long-term development initiatives, such as training.

These institutional changes have had two effects: first, transferring the project from one office to another broke the administrative continuity; second, transfer of the project to AFR/TR denotes a subtle shift in project emphasis that results in a blurring of bureau mandates and hence overlapping initiatives.

The immediate consequence of the transfer of the AELGA project from AFR/OEO to AFR/TR was a loss in project continuity, as the staff who had initiated several project activities were reassigned to other undertakings. Even more importantly, the new staff in AFR/TR had to manage the project without sufficient support personnel. The new project management had to set up implementation mechanisms and deal with programmatic concerns, even as new locust outbreaks threatened the continent. As a result, some longer-term project initiatives, such as training (Section D-3e), lost their momentum. (The importance of administrative continuity will be a major factor in the decision over whether to transfer AELGA again, this time to the new AFR/OEC. This would not be advisable at present, and should be undertaken only if the recommendation for a follow-on, umbrella food-security or disaster project is accepted.)

The second consequence of the changing institutional locus of the AELGA project is more subtle. The creation of the DLTF in August 1988 complicates the institutional arrangements. In particular, OFDA/DLTF naturally views AELGA as an emergency operations assistance project, which was the thrust of the original design. By contrast, AFR/TR, which is now responsible for the AELGA project, understandably takes the view that AELGA is more properly a longer-term institution-building effort. This view reflects both the AFR/TR mandate and the changing thinking about the nature of the locust emergency now that the problem has recurred for several years.

This natural shift in the perception of the nature of the problem underlies many of this evaluation's recommendations. It was clearly an emergency situation when the locusts first broke out: unless action was taken quickly, Sahelian farmers who had for several years suffered from drought would lose their crops and would, it was thought, likely starve. The choice, then, was between a rapid and widespread locust control operation--which meant aerial spraying--or the possibility of a massive and costly food-lift operation. As the locust emergency has recurred for several years now, the appropriateness of this disaster relief mode becomes more questionable. For, while the immediate outbreaks of locusts must still be dealt with, it is clearer that the control of future outbreaks--which constitutes the second major purpose of the project--can only be effectively dealt with through long-term institutional development of regional organizations, national crop protection services, and local action committees. In other words, while emergency operations will continue to be necessary in response to locust outbreaks, longer-term institutional development is equally necessary in order to reduce the cost and complexity of those operations and to better prepare for future outbreaks. The AELGA project must incorporate both aspects of the problem. But the project must also clearly separate these two undertakings. To allow the emergency operations to continue to overwhelm the longer-term aims of the project may resolve the current crisis, but it will do little or nothing to help control any future outbreaks, which is the stated second purpose of the AELGA project.

The consideration, then, is not the impact of the DLTF on the AELGA project, but of the coordination of these two units, each of which is located in a different bureau, with a distinct mandate.

3. **How well does AELGA management coordinate activities with DLTF, S&T/AGR, Africa Bureau environmental officer, other agencies Pest Management efforts, etc?**

AELGA management coordinates closely with the agencies and officers most concerned with locust control operations. The AELGA project officer attends the weekly DLTF meetings. The project officer consults informally with the pesticide expert in S&T/AGR. And, the present Africa Bureau environmental officer was a former AELGA project officer, and has an office not far from the present project officer.

OFDA/DLTF is the most important of the offices with which AELGA must coordinate. Apart from the formal coordination of the weekly DLTF meeting, AELGA and DLTF staff consult with each other quite frequently. This cooperation was even closer in the past, when the USDA/OICD technical assistant spent about half of his time working with OFDA on locust problems. Nonetheless, there have been difficulties in coordination, particularly when the project was first transferred to AFR/TR. Because AFR/TR was then not prepared to carry out an emergency operation, OFDA took the lead in organizing locust support activities. In one case at least, this leadership involved requesting USDA/OICD assistance under the AELGA RSSA without prior consultation with the AELGA project officer. It is recognized by all parties concerned that this request was bureaucratically incorrect, and the situation was remedied by the USDA project officer.

4. **Is adequate logistical support (secretarial, computing facility, cartography) being provided?**

The AELGA project has not enjoyed adequate logistical support. The project officer shares one secretary with several other technicians. And, there is neither a computing facility nor a cartographic facility.

The problem here largely concerns personnel ceilings. AFR/TR was assigned an additional project, AELGA, without any increase in personnel or funds. In consequence, the project is being implemented by a single project officer, assisted from time to time by technicians made available under the USDA/OICD RSSA.

Because the AELGA project involves both emergency procurement and longer-term development activities, including research, it is strongly recommended that an intern be assigned to the AELGA project under the USDA/OICD RSSA. This individual would assist the USDA entomologist in the daily project routine. The USDA specialist would then have more time available to establish and oversee the implementation of an appropriate training and research program. The project officer could then focus on administrative matters and short-term procurement procedures.

5. Is collaboration with other donors successful?

AELGA collaboration with other donors mostly involves the FAO/Rome. This relationship has improved significantly over the past two years (Section I C-6). Even so, the change in staff on the project, as well as the creation and dissolution of offices (including OFDA/DLTF), means that other donors may not always be certain who is responsible for the project. Moreover, the individuals, who come from different offices within USAID/W, have different ideas about the nature of AELGA and its aims.

In-country, the FAO often has titular responsibility for coordinating the desert locust control program. In some countries, the FAO resident representative has played a key role in coordinating donations. In other countries, he has played a small or insignificant role. In these cases, either the host government or the USAID mission itself has played the key role of coordinating among the donors. AELGA, of course, is not directly involved in collaboration at this level, although some of its resources are used by USAID missions for locust control.

6. Evaluate the AID relationship with FAO and assess the quality and quantity of FAO outputs under AID grants for desert locust control (FAO Grants 698-0517-G-IN-8995-00; 698-0517-G-IN-8996-00; 698-0517-G-IN-8997-00).

The FAO has a key role in desert locust control because it is the international coordinating body for the regional locust control organizations (e.g., OCLALAV, DELCO). Moreover, FAO has kept up-to-date on developments in locust forecasting and monitoring through its special ECLO unit, which is staffed by dedicated technical experts. Thus, in an emergency situation, the FAO has been able to alert the donor community and to coordinate their participation. The FAO has also been able to procure commodities and technical services for locust control and to obtain legal clearances for fly-over rights, among other matters.

The USAID relationship with the FAO on locust control has become exemplary. Essentially, USAID has provided resources to the FAO/ECLO for regional locust control. (There has been significant participation by OFDA/DLTF in the determination of these resources.) To strengthen this relationship, it would be important to assign a qualified technician detailed from AELGA to the FAO/ECLO forecasting unit.

The USAID-provided resources are three grants to the FAO. One grant provided short-term entomological assistance to USAID/Mali. This entomologist is a world-renowned expert on locust, and he had previously worked directly for the USAID mission. The second grant provided spray equipment to USAID/Mauritania; it was essentially a procurement arrangement. The third, and largest, grant was intended to establish regional offices for coordinating locust control operations. There is no real objection to either of the first two grants; however, the third grant warrants closer examination.

The grant of 2.1 million dollars to the FAO was originally intended to establish two regional offices for coordinating the locust control program, one in Dakar and one in Niamey. In the event, only one office was established, that in Dakar, as the need for an office in Niamey dissipated with the plague threat there. The FAO/ECLO Dakar office was housed in the OCLALAV building. But, despite a legal convention between the two organizations, FAO/ECLO maintained an essentially independent operation from OCLALAV. While this arrangement may have been necessary at the time--OCLALAV, the regional locust monitoring and control organization, was not functioning well and has only recently been redefined by the heads of the OCLALAV states as a coordinating body with no operational role--the consequence of the independent FAO/ECLO operation was to undermine further an already weak organization. (FAO/ECLO also created more confusion about locust reports by ignoring or revising official reports.) Thus, at the end of the USAID grant (June 1989), FAO/ECLO intends to hand over the communications equipment to OCLALAV, which has no funds to operate the system. A skeletal FAO/ECLO unit must be maintained in Dakar, and this unit must be contractually required to collaborate closely with OCLALAV in its newly redefined role of coordinating agency.

A significant portion of the USAID grant to FAO/ECLO has benefitted the crop protection services in the OCLALAV countries. The FAO has, with AELGA funds, purchased telex and telefax machines, as well as radios for communication. Approximately $500,000 of the original grant were not spent, and these funds are being reprogrammed for survey teams. Although it is important to strengthen the national CPSs, it is questionable whether the FAO represents the best channel for this work. USAID missions have little or no control over these funds; indeed, they are often unaware of the AELGA supplied equipment and training. A better arrangement might be to provide funds for equipment directly to the USAID missions and to fund centrally the training programs through OCLALAV, which is specifically charged with this function.

In summary, the FAO has played an important role in locust control operations over the past few years. At the time, FAO/ECLO was the only functioning organization in locust control. That situation has changed dramatically, so that what was then unavoidably necessary is now no longer the only option. AELGA needs to respond flexibly to this changing situation. Specifically, the project should consider participating in the locust monitoring and forecasting work being done at FAO/Rome. It should continue funding for the FAO/ECLO office in Dakar, with the specification that ECLO/Dakar work in close collaboration with OCLALAV. And, it should provide resources for locust control directly to the USAID missions, and provide training through--or at least in association with--OCLALAV, now that its role has been more manageably defined.

7. **Does the project work plan adequately address incentives to promote development and maintenance of a well-established core of professionals, within each host country's crop protection service, to provide continuity during plague and recession cycles of locust/grasshopper abundance?**

The project work plan does not provide incentives to develop and maintain a well-established core of professionals within each host country's crop protection service.

AELGA has provided commodities and services to assist the national CPSs in emergency locust control operations. The project has also helped USAID missions carry out their own operations. And, through the FAO umbrella grant, the project has provided some equipment to national CPSs. These discrete activities, however, do not compose a coherent program for locust control in national agencies. For more on incentives see item 10 in the case studies.

AELGA can rectify this situation in two ways. First, it can support the short-term operational training within national CPSs that is necessary for ground and aerial reconnaissance and control operations. Relatedly, the project can provide critically needed assistance through the USAID missions, such as contributing to the construction of adequate storage facilities for pesticides. Second, the project can require that the FAO earmark a portion of its funds under the AELGA umbrella grant to regional and national surveillance agencies. The FAO is arguably the only agency now able to carry out locust monitoring in the distant breeding areas. Nevertheless, the FAO would be required to collaborate closely with these other agencies so that they could take over these activities in the future.

8. **What, if any, are the incentives for host countries to maintain this nucleus of trained professionals?**

Host countries will naturally be more interested in crop protection than in monitoring the remote breeding areas of desert locust during periods of remission. Nonetheless, it is precisely these strategic areas that hold the key for future locust control. If as has been recommended, crop protection agencies receive the training and support for locust control in agricultural areas as well as in more remote breeding areas, it can only be hoped that they will discharge this obligation faithfully.

Sections II B-F10 of the case studies details the incentives that currently exist in each country and those that might be considered in the future.

D. IMPLEMENTATION

1. How were mission requests analyzed and decisions reached on levels or limits of assistance provided?

According to the project officer, mission requests were handled on a day-to-day basis, as they arrived in AID/W. Decisions were reached on the levels or limits of assistance in terms of the funds available at that time. No mission request for assistance has been denied in its entirety, although the extent of assistance has, as mentioned, been limited by the project resources available (Section I B-1).

2. Does the project provide for timely responses to requests for support?

The project can provide for timely responses to mission requests when funds are available and innovative implementation mechanisms are already in place (Section I D-4, below). For example, both Mali and Niger used mission funds to buy needed amounts of pesticide through the project's pesticide bank. With both the funds available and an implementation mechanism in place, the supplies could be--and were--shipped within 30 days of the request. This is a rapid turn-around time and can provide for a timely response. Whether the response is in fact timely depends on vagaries of the weather. Desert locusts are very mobile under certain climatic conditions, and a swarm might move into and out of a country within a month.

The project faces much greater difficulty in expediting requests for AELGA funds by the missions. The difficulty lies in the nature of AELGA financing. When the AELGA project was transferred to AFR/TR, that office had not received its annual budget allotment from AFR/DP, a situation that very much depends upon the congressional budgetary cycle. Thus, the amount available for project activities was uncertain, and consideration of mission requests delayed until funding levels were determined. This understandable delay can result in a belated response.

USAID/Chad was involved in just such an instance in 1988. The mission had been alerted of a probable locust build-up in late 1987. The mission planned its control program on the basis of the GOC country plan and the views of short-term technical experts. The mission then cabled its request for integrated assistance--technical assistance, pesticides, and aerial spraying--to Africa Bureau in January 1988. AFR/TR, however, could not respond until its AELGA project budget had been set, which occurred in April of that year. Even then the only assistance that could be provided under the project was the purchase of pesticides. Unfortunately, this delay meant that the pesticides arrived in country just as the rains began. Because of the very poor road infrastructure in Chad, the Mission faced tremendous logistic difficulties in positioning the supplies. In fact, the supplies reached Abeche two months later, well after the locust

threat had dispersed. Those stocks now sit in a warehouse in that strategic center, in anticipation of any future outbreak.

The procurement usually required in a development project also cause delays in an emergency situation. The USAID/Cape Verde request for backpack sprayers is just such an example. The request to purchase a specific backpack sprayer was made late last year, after the Ambassador's declaration that an emergency existed. Although AELGA project had a predominant capability waiver for procurement, SER/MO questioned the purchase of a specific type of sprayer. Only when the proper justification had been provided--these sprayers last longer because they have brass nozzles, and they are the sprayer preferred by the GOCV--was the procurement impasse resolved. Again, precious time was lost, although the sprayers will be in country for use this year.

These incidents well illustrate the difficulty of implementing an emergency action in the conventional developmental framework, and they underscore the importance of putting in place those implementation mechanisms that will facilitate emergency response.

3. **Evaluate the effectiveness of the following implementation mechanisms:**
   - **a) RSSA (USDA, USGS);**
   - **b) Mission allotments of core funds; and, mission buy-ins;**
   - **c) pesticide bank;**
   - **d) CICP buy-ins; and, research contracts; and**
   - **e) regional training programs.**

This query poses several, distinct questions. It also omits one important implementation mechanism that warrants review--the FAO grants procedure. In fact, each implementation mechanism has succeeded to some extent, for different reasons in each instance. The overall effectiveness of each mechanism may be assessed as follows:

a. The RSSAs with USGS and USDA succeed well in bringing longer-term technical assistance to the project, but, expectable they have more difficulty providing short-term technical assistance on short notice.

b. Mission allotments of core funds, often termed "mission buy-ins," are fine in theory but are, for emergency projects, cumbersome and inefficient in practice.

c. The pesticide bank is an innovative and workable implementation mechanism, well adapted to the exigencies of this project. Unfortunately, administrative actions prevented the operation of the bank as originally intended. Also, the pesticide research program designed to inform the selection of agents to be stocked in these banks has become divorced from decisions on which banks to establish. Nonetheless, the idea of a pesticide bank is an important innovation in this project.

d. CICP buy-ins and research contracts both succeed to the extent that project management has the technical expertise necessary to guide decisions on those endeavors.

e. The regional training programs have yet to be implemented in the manner and according to the schedule originally envisioned.

f. The FAO grants are a cumbersome and expensive implementation mechanism for operational activities. While AELGA might properly continue to support FAO activities in locust forecasting, there are strong reasons for discontinuing immediately the use of grants to the FAO for operational activities, including technical assistance. Specifically, the use of this mechanism significantly increases costs without any gain in efficiency, which effectively reduces the funds available for other needed activities. Commodities and services are not delivered in timely enough fashion for use in the emergency situation that initially justified their procurement. The FAO accounting for funds has been vague at best. And, the use of funds by FAO has been duplicative--if not contradictory--to USAID program goals, which matters have not always been drawn to the attention of the concerned USAID missions. These concerns are discussed in detail in Section I C-6 of this report.

The observations of the evaluation team that underlie each of these overall summaries are detailed below.

a. RSSA (USGS and USDA)

The loan of government personnel with specialized knowledge between different agencies (RSSA) has proved very effective for the longer-term aspects of the AELGA project. The provision of short-term technical assistance has encountered the usual problems of locating qualified experts who are interested and available on short notice.

The RSSA with USGS has been particularly effective because it involves long-term technical assistance in a specific domain and because requests for short-term technical assistance are fulfilled by the same permanent staff of that agency. Under the RSSA with AELGA, USGS provides greenness maps with a resolution of 1 km^2 for locust surveys, along with an interpretation of these materials. This information is provided on a timely basis: the analysis and interpretation of remote sensing data are cabled to missions within 24 hours of the receipt of the raw data from NASA. The actual maps are sent by special courier to the missions within two weeks. Thus the missions have early warning of possible feeding areas for locust swarms and soon afterwards receive the actual maps, which are very useful in coordinating survey and control activities.

Short-term assistance under the USGS RSSA has mostly involved training for nationals in the interpretation of the maps. (The interpretation of remote sensing data is very much an art, for this is no codified set of interpretive rules. The analyst must be able to assess the significance of particular data, and he or she must be able to reject

spurious findings). USGS has used the home office staff most directly involved in the interpretation of the greenness maps to conduct these short courses. These staff are intimately knowledgeable about the project and the greenness map activity. Importantly, these staff also have long experience in West Africa and are fluent in French. Thus they are uniquely able to instruct national trainees in greenness map interpretations and the pitfalls therein.

The USDA RSSA has involved both long-term and short-term technical assistance, as well as the procurement of commodities and services. Each of these activities must be considered separately.

Long-term technical assistance provided to the AELGA project under the USDA RSSA has been particularly effective. The long-term desert locust entomologist has provided pertinent expert guidance throughout his association with the project. This individual is uniquely qualified for this position because of language and country experience, as well as technical qualifications. He has provided significant short-term technical assistance to the project during his two-year posting. Another superbly qualified technical assistant worked for AFR/TR for another six months, before moving to assist in OFDA locust control operations. The long-term environmental scientist has overseen the conduct of the pesticide research, and he has been charged with developing the programmatic economic cost/benefit analysis. This person has provided no short-term technical assistance abroad because he has neither language nor country experience skills.

USDA-provided teams for survey and control operations have been notably effective. USDA was able to call upon APHIS (Animal and Plant Health Protection Service) for three entomologists to survey locust infestations in several countries and to make recommendations for the operations there. USDA also provided three short-term entomologists to Niger for the conduct of locust surveys and one facilitator for the coordination of aerial spraying. In addition, USDA has provided one individual for survey work and crop protection in Mali, and it has participated in a control team in Mauritania, providing a logistician and an entomologist for the spraying operations there. Despite a somewhat tardy start-up, the team in Mauritania successfully carried out its mandate. The difficulties encountered in this instance have more to do with the tardy receipt of locust alerts than with bureaucratic delays. The teams fielded by USDA have gained important experience from the operations and have made recommendations for future operations (Stancioff 1988).

USDA has on one occasion provided other short-term technical assistance--a pesticide handling expert to recommend techniques for the disposal of pesticide drums in Niger. USDA could provide other such technical assistance on a timely basis were it requested. (See section II D.)

In fulfilling these requests for qualified assistance within a very short timeframe, USDA faces the same difficulties as any contractor. The number of experts qualified in entomology and experienced in locust control operations is very limited. Few such experts know the languages spoken in the countries where the work will be carried out. (And, others are simply not interested in short-term work abroad.) The small pool of

qualified, experienced, and interested experts makes it very difficult to respond in a timely manner to immediate requests for assistance. This is a difficulty any contractor would face. And, only the extraordinary dedication of the USDA project staff accounts for the remarkable success the agency has had in fulfilling requests.

In this regard, it is important to note that USDA/OICD is no better organized to handle requests for emergency assistance than are the geographic bureaus of USAID. This situation has posed particular difficulty in the emergency procurement of supplies and services. USDA/OICD's participation in short-term provision of commodities began only in 1988, when it received a request for 466 barrels of malathion to be sent to Mali and Niger. The agency was able to ship the material within two weeks of the receipt of the request by using existing USDA procurement mechanisms and by leasing a plane for the shipment. Nevertheless, it took the full two weeks of constant work by the project staff to negotiate prices with suppliers, obtain necessary fly-over rights, coordinate with the concerned USAID missions and the like. Although the USDA/OICD staff undertook this logistic operation for an emergency response and worked with exemplary dedication, they were admittedly unprepared for the complexity of the undertaking. Every activity, e.g., negotiating prices with supplies, was for them a new and unfamiliar undertaking, and though they worked with aplomb and speed, their dedication meant that all other project management activities had to take second place. This, of course, is precisely the problem that AFR/TR faces in the implementation of AELGA emergency operations. In other words, emergency contracting of supplies through USDA/OICD displaces, but does not eliminate, the problems encountered.

In sum, US government agencies are specially able to provide long and short-term technical assistance through a RSSA to the AELGA project. These agencies--USGS and USDA--have built up strong rosters of technical expertise that they can call upon to carry out certain activities. These agencies cannot, however, be expected to procure other services or commodities, for the simple reason that they, like AFR/TR, must work within the regular procurement process of the US government.

b. Mission allotments of core funds and mission buy-ins

Mission buy-ins to the AELGA project are in theory an attractive implementation mechanism. In practice, however, mission buy-ins have proved cumbersome and inefficient for a number of intractable reasons.

In theory, missions allot core funds to buy into a central project in order to obtain a service that the missions require but are unable or unwilling to obtain through a full-fledged project of their own. The reasons why a mission may call upon a central project for assistance are various: the service required fulfills revealed needs in an on-going project; the service available centrally provides technical expertise to design a similar project. In these situations, buy-ins complement existing or planned projects. And, indeed, this implementation mechanism works best where the mission can plan for buy-ins during the usual course of its regular programming cycle. The mission can in this situation judiciously weigh the competing claims on its limited resources and define the optimal overall program.

From the field perspective, an emergency situation means that a mission without a project in that area must call upon the existing central project to provide the needed but unanticipated services. In this case, which is most relevant to AELGA, missions in countries threatened by a locust plague allocate funds to the AELGA project in order to obtain services for the control of the impending disaster. Without much prior warning, the mission must earmark funds from its existing projects in order to contribute to the central project. Because health,population, and environmental projects have been congressionally mandated, the cuts among existing projects may fall disproportionately on other sectors. An emergency situation can, in short, seriously imbalance a mission program. Further, it should be pointed out, a mission that cuts existing projects in order to finance an emergency disaster relief project one year will likely be sorely taxed to undertake a similar effort the next year should the need arise. Emergency buy-ins, from the missions' point of view, are viable only if they occur infrequently and sporadically.

In sum, while the minor administrative problems that have beset the buy-in mechanism from time to time might well be overcome with experience, two factors--the budgetary delays that typically occur in Washington for reasons far beyond the control of project authorities, and the process of allocating limited funds among projects in a mission--mitigate against the mission buy-in mechanism as an effective instrument for the implementation of emergency assistance. Mission buy-ins work best in a development context. They can be made to work (most times) in an emergency situation. But even in that happy event, they have serious--and at times deleterious--consequences for the existing mission program. These consequences much reduce the effectiveness of the mechanism for emergency implementation.

c. Pesticide bank

The pesticide bank represents one of the most innovative implementation mechanisms devised under the AELGA project.
The pesticide bank is intended to operate in the following manner. Through AELGA, U.S.A.I.D. prepays a manufacturer to guarantee that a stipulated amount of a specified pesticide will be available upon call. In the case of need, a mission can "buy into" the AELGA pesticide bank up to the amount available in the account. The product is shipped immediately, and the mission funds are used to restock the account for other future needs. Establishment of the pesticide banks is thus an example of a mechanism created to respond to an uncertain need. Its existence enables project management to respond efficiently to field requests.

Because of bureaucratic error,the pesticide banks do not all exist and in one case does not yet operate in the way originally intended. Originally, the pesticide research program was intended as a way to determine which pesticides would be most efficacious, economic, and ecologically sound under different conditions. This research would therefore guide the selection of chemical agents, for which banks would be established. With a range of chemical agents available for different conditions, field missions could

better tailor their response to the crisis at hand. Instead, it appears, when the documents to establish the banks went forward, only the malathion bank was set up because that was the only chemical agent then available. While malathion is a conservative choice because it breaks down quickly upon application, missions have not been provided the opportunity to tailor their response more effectively.

Second, the pesticide banks were supposed to operate like revolving funds. That is, stocks drawn out by one mission would be replaced with that mission's funds for the future use of that or other missions. Unfortunately, the PIO/C that authorized the malathion bank stated that this was to be a one-time (rather than continuous) action. In consequence, the malathion bank, which was effectively deleted by the demand from Senegal last year, has yet to be replenished. (And, therefore would have proved ineffective had another outbreak occurred, either in Senegal or elsewhere.) This error was not repeated in the establishment of the carbayol bank; however, this bank has yet to be called upon by any USAID mission.

In summary, the pesticide bank represents an innovative mechanism to put into place a procurement system that anticipates unknown needs so that, in an emergency, supplies can be shipped forward quickly. The implementation of this innovative approach has, however, been sadly wanting. In the event, all of the banks that had been envisioned were not established. And, the most important bank (and the only one that has been used) lacked the crucial revolving account provision. These administrative "errors" have fortunately not had devastating consequences on locust control programs, and may in fact be the better way to anticipate purchases.

d. CICP buy-ins and research contracts

The research activities being undertaken for the AELGA project have not yet been notably productive and will require redoubled attention to repay the investments being made.

The areas of research--assessment of the efficacy of different pesticides under different conditions, and the assessment of crop losses for economic cost/benefit analyses of locust control operations--are major, pertinent concerns in the field of locust control. These areas were identified early on in the project identification phase as important, and they remain so today.

However, the contracting for this work through existing implementation mechanisms--specifically, the CICP contract with S&T Bureau--is too long--AELGA to S&T/AGR to CICP to Oregon State University. This implies a dilution of authority and clarity in goals.

The real problem appears to be insufficient technical and management attention devoted to the studies. First, the research contracts must be reviewed closely by a qualified technical panel for feasibility and relevance. Second, the work must be carried out in close collaboration with the national research institutes so that the research program is implemented correctly. Third, the expatriate researchers must contact the USAID

mission and keep them informed, without becoming a logistics or administrative burden. Otherwise, as the AELGA experience demonstrates, even good research protocols will fail and the research results will be unusable. AELGA project management must insist upon all of these matters--and upon timely delivery of contractor reports-- for the success of the research being done. These technical research concerns are taken up in greater detail in Section III B-2-8.

e. Regional training programs
(See also Sections III A-8 and III E-9)

That the regional training program took place in PY 1 but not in PY 2 only underscores the difficulties of institutional development during emergency operations. Nonetheless, such training must be undertaken before the end of the project in order to achieve the second project purpose of establishing "improved management and control mechanisms that will keep this problem under control in the future"

The project paper envisioned that training would be provided at three levels--policy and management, technical matters, and field operations (p.22). The purpose of these training sessions was to assure that trained personnel "are available in sufficient numbers to facilitate the implementation of the Country Plans" (p.6) for treating the pest problem. The topics to be taken up in each level of training session are not specified in the project paper. But the project paper does state that training activities would be planned and organized in PY 1, when syllabi would be tailored for each level. These syllabi would take advantage of the work done by other donors. Most of the field agent training would, therefore, take place in PYs 2 and 3 (p.30).

In the event, several training courses were held in PY 1 (1987); none were held in PY 2 (1988), reportedly because emergency operational expenses overwhelmed the AELGA budget that year (Section I B-1); and, several courses are planned for the current year (1989).

Two types of training sessions were held in PY 1, a general course for crop protection agents to act as trainers of farmers and a more specific course for crop protection service managers in ultra-low volume (ULV) aerial applications of pesticides.

The two-week long field agent training course covered a wide range of topics: crop protection products, precautions in their uses, aerial applications, environmental effects, ground applications (with training in calibration), locust campaign strategies, grasshopper identification, and farmer training in these areas. This course was given in Banjul, The Gambia (March 30-April 10) and again in Dakar, Senegal (April 15-30). The course, organized by a USDA employee on secondment to AELGA in collaboration with CICP (Oregon State University), received favorable assessments from the participants, and appears to have been effective.

The short course in ULV applications for CPS managers, by contrast, appears to have been less effective because, while the heads of the national CPSs need to know about ULV, they are not the people who actually carry out the operations nor are they

individuals who are likely to train the operators. In brief, the course was pertinent to AELGA aims. But the audience was poorly selected in that it did not include those individuals who actually carry out or directly supervise the operations.

The early implementation of these training courses, given everything else that was happening at the time, could have provided a very strong basis for the development of training courses in PY 2. Plans were developed for several courses--grasshopper and locust identification, ULV applications, crop loss assessment, and the training of trainers. Unfortunately, these plans were not carried. The precise reasons for this failure are unclear: both reassignment of AELGA to AFR/TR with the dissolution of AFR/OEO and the unexpectedly great administrative and financial requirements of emergency operations that year have been mentioned as contributing factors. Whatever the reasons, the fact remains that training, which is so fundamental to institution building, did not occur apart from actual field operations.

Two courses are scheduled this year, in April, in Niamey, one course is for the development of training materials for trainers and the other is for ULV applications. These courses will be carried out under the USDA RSSA.

In the opinion of this evaluation team, the nature and extent of training undertaken by AELGA to date warrants expansion and reorientation, despite the explicit (but contradictory) statement in the PP that institution building is not a direct aim of the project. Practical, in-country training is a fundamental aspect of institutional development. It is the only way that improved management and control mechanisms can be implemented in order to keep the locust problem under control in the future. In simple terms, this means that the people who carry out a locust operation must understand what they are doing and why. Moreover, their direct supervisors must be equally, if not more, knowledgeable about what to do and how and about the consequences of improper locust control activities.

In order to achieve the second purpose of the AELGA project, training must be undertaken in a number of areas, including grasshopper identification, the health consequences of pesticide use, and the environmentally sound disposal of surplus pesticide and of containers. In addition, the training should cover farmer brigades, reporting procedures, and terrestrial surveillance and control. This training must aim to strengthen the CPS of each country so that CPS agents can work with farmers, who in many areas represent the first line of defense against locust plagues. These training recommendations constitute the key suggestions contained in Recommendation Set 2.

In all instances, the training must be practical and field oriented. For this reason, most such courses should be organized with participants from a single country and with at most a few observers from neighboring countries. The alternative, to select one or two people from each CPS in each member state, typically leads to a high-level audience with great responsibility but little daily field oversight responsibility. While these staff should be made familiar with the recommended techniques and approaches, the need at this point is more for field-oriented, operational training for local level staff.

Finally, the training of trainers has, admittedly, become very fashionable, for the simple reason that the approach promises widespread effect. In the event, the hoped-for cascade effect seldom occurs because there is little or no responsibility placed on the trainers to communicate or extend their new knowledge. For the training of trainers to be truly effective, the newly trained agents must be responsible for the actions, or for the lack of them. Such responsibility must be built into the system where it does not already inhere. For example, CPS agents charged with teaching farmers how to identify locusts and grasshoppers can follow up by periodically attending local markets in order to reinforce their lessons as well as to collect reports of areas of probable infestation. Within the CPS itself, supervisors can be held personally responsible for the health of their workers and for the environmental safety of their depots and their control operations. For example, field supervisors can be taught the health concerns of pesticide handling and use. They in turn can teach these materials to their workers, which would serve to fix the ideas in their minds and to make them responsible for any intoxification of their staff. The same can be done with the storage and use of pesticides. The key to the success of the training of trainers is to ensure that the trainers are responsible for the future health and safety of their trainees.

4. Identify mechanisms that work and should be continued, and also any constraints to implementation plus any methods to be used to overcome or circumvent them.

As an emergency assistance project, AELGA must put in place implementation mechanisms that will enable project management to call forward those commodities and services necessary for the timely response to emergency situations. Some of these mechanisms have already been put into place; others require immediate implementation. The mechanisms that work and warrant continuation, as well as those that could be used, are detailed above. These mechanisms constitute Recommendation Set 1 of the Executive Summary, and have just been discussed in Section I D-3 above.

II. THE INTERNATIONAL SYSTEM OF LOCUST WARNING AND CONTROL AND CASE STUDIES OF THE NATIONAL LOCUST CONTROL PROGRAMS

(SOW Section VII-A: Evaluate the current and project locust/grasshopper programs. Analyze options, decisions, and evaluations from available records of host country, missions, regional organizations and FAO.)

A. THE INTERNATIONAL SYSTEM OF LOCUST WARNING AND CONTROL

The international system of locust warning and control dates to the mid-1950's. In 1954, on the recommendation of the Working Party on Desert Locust Control, the Director-General of the FAO recommended the creation of the FAO Desert Locust Control Committee as an expansion of the previous Coordinating Committee for the Control of the Desert Locust in the Arabian Peninsula. The charge of this committee is: to keep the desert locust situation under review; to coordinate the locust control campaign in affected areas; to promote the overall coordination of work by various national and regional anti-locust organizations; to provide technical and scientific advice on the locust situation and on the measures required to keep it under control; and, to give general policy guidance. The committee brings together the countries in the various regions that are plagued by desert locust.

Subsequently, different regional groupings of countries were constituted to combat the locust problem. The Commission for Controlling the Desert Locust in the Eastern Region of its Distribution Area in Southwest Asia (DL/SWA) was formed in 1964 by Afghanistan, India, Iran and Pakistan. The Commission for Controlling the Desert Locust in the Near East was formed in 1967. The Commission for Northwest Africa was formed in 1971. And the Organization Commune de Lutte Antiacridienne et de Lutte Antiaviare (OCLALAV) was created in 1965 to regroup the West African States south of the Sahara. Each of these committees is charged with: maintaining a permanent locust information and reporting service; maintaining an adequate locust control service; holding reserves of insecticides and application equipment; encouraging and supporting training, survey and research work; participating in the implementation of any common policy of locust control; facilitating the storage of anti-locust equipment; and providing the Commission with any information requested.

Thus, at the time of the latest locust outbreak in West and North Africa in the mid-1980s, the international locust control system comprised a coordinating committee based at the FAO in Rome that oversaw the different regional bodies, all of which were charged with monitoring and control of locust, as well as with training.

This system was able to alert the international community about the likelihood of a serious locust infestation in 1986. However, the regional locust control organization for the Sahel, OCLALAV, proved unable to carry out its operational mandate. Confronted by the reality of a locust emergency that could not be contained by the appropriate regional organization, FAO itself undertook the role of regional surveillance and coordination, with significant funding from USAID under the AELGA project. (This is

the FAO umbrella grant, which funded two coordinating offices, one in Dakar and one in Niamey.) While FAO/ECLO discharged its technical duties admirably, the creation of a parallel and largely independent body unwittingly but effectively further undermined the capability of an already weak organization.

These experiences have caused a significant reorganization of the regional locust response capacity. First, meeting in late February 1989, the Heads of State redefined OCLALAV as a coordinating body for locust control information and training. The earlier operational role of OCLALAV was reassigned to the national crop protection services (CPSs). Second, in mid-March of this year, the heads of the national CPSs met in Dakar under the aegis of CILSS/INSA to discuss and determine a conjoint program for locust control and crop protection.

This reorganization may better meet the needs of locust control programs, but it also raises new questions. In particular, the CPSs will naturally be oriented more toward areas and periods of agricultural production. In accord with their mandates, they will be less concerned with the remote, non-agricultural areas that typically serve as the breeding grounds of the locust. Thus a monitoring capacity must be created to deal with this strategic problem. FAO/ECLO has coordinated this monitoring in recent years and will continue this work this year, with AELGA funding. While it is incumbent to continue this work, FAO <u>must</u> be required to work closely with OCLALAV, CILSS/INSA and the national CPSs, in order to develop a <u>regional</u> capacity for strategic monitoring.

Because the international and regional locust control system in the Sahel is in a state of flux at the moment, this evaluation team strongly recommends that AELGA adopt a flexible approach to developments in the region. Specifically, the team recommends a two-pronged approached. First, the project can support survey and monitoring activities under the auspices of the FAO/ECLO, but in that case the project should require that organization work in close collaboration with OCLALAV and the national CPSs. The point here is simply that FAO must be required to help build the institutional capacity in the region to carry out these surveys. Second, the project can support national crop protection services in the areas of operational training, health and safety awareness, pesticide storage and disposal, environmental consequences of continued pesticide use, and the like. This work can be carried out in collaboration with the USAID mission in country, CILSS/INSA, OCLALAV, or the FAO/ECLO. Again, the aim of this work is not simply to conduct training sessions but to build a regional institutional capacity. For this reason, it is recommended that a percentage of the AELGA funds granted to FAO/ECLO be earmarked for regional and national institution building and that the FAO/ECLO be required to devise a program of activities acceptable to all parties for that end.

B. CHAD CASE STUDY

1. Background

AELGA has not been much used in Chad. One AELGA contribution consisted of 30,000 liters of malathion 50% ULV which was requested in January, 1988, and did not arrive in Chad until July. The insecticide was intended to be positioned in Abeche where locust activity had been reported by the CPS in early 1988. The malathion did not reach its final destination until two more months had elapsed; now the malathion is cached in a storehouse in Abeche, having arrived too late to be of use in the locust campaign. This anecdote well illustrates the opinions encountered at FAO, Rome, with regard to AELGA's inability to respond to emergency requests in a timely fashion.

In addition, USAID/Chad had requested technical assistance, greenness maps, and logistical support along with the malathion. AELGA management failed to respond to these needs, and the USAID mission eventually turned to USDA for technical assistance through a RATSA. Mr. Garbinski, a livestock specialist, was sent instead of an entomologist. Also, AELGA funds under the FAO grant ECLO/RAF/019/USA (698-0517-G-IN-8997-00) were used to help support FAO entomologist John Egle (Nigerian) who was stationed within the Chadian CPS for three years. He produced a report (Operation de lutte contre le criquet pelerin au Tchad 1988) which was co-funded by ECLO/RAF/013/NET on pest management in Chad. His recommendations were not specific to L/G (Locust/Grasshopper), and did not contribute significantly toward the amelioration of anti-locust efforts for the consideration of the Chadian CPS, but the report did indicate that the locust campaign in Chad has suffered from logistical weaknesses including shortages of spare parts for vehicles and spray equipment.

USAID/Chad does not wish to focus upon locust activities, as it is overburdened with five other agriculturally related projects. The agricultural officer indicated that approximately 70 percent of his time in 1988 was monopolized by locust concerns, and he felt this was an inappropriate way to utilize such a large portion of his activities. Furthermore, he did not recommend that the USAID mission institute a pest management program within its framework, especially since the UNDP plans to initiate a pest management project in early spring, 1989. In addition to the desire to avoid duplicating UNPD/FAO efforts, the USAID mission is not staffed or budgeted adequately to deal with an additional project, and the mission cannot realistically provide year-to-year commitments on pest control. USAID/Chad has, however, drafted a proposal to procure $20,000 local currency for crop protection purposes (perhaps for survey team or materials transport and fuel); the remainder of the moneys will be obtained from residual funds, which OFDA may approve for use in 1989.

The Chadian CPS has been developing a system for the last two years for the locust campaign, and, according to both the FAO representative and the USAID mission in N'Djamena, progress has been evident. The CPS has also just opened an extension arm of the CPS but adequate training is still a problem. OCLALAV did not operate in

Chad until 1987, and even now is relatively inactive, although OCLALAV has in one instance assisted the CPS in southern Chad.

The advantage of AID-funded insecticides is that AID is very conscientious about the monitoring of donated pesticide stocks due to the imposition of US regulations. A disadvantage is that the waiver process has caused the rejection of pesticide requests due to a "lack of justification."

At present, although the Chadian CPS has requested 600,000 liters of insecticide for 1989, stocks are now sufficient (at least 160,000 liters of anti-locust compounds alone). In 1988, 35,000 liters of lindane ULV (FAC), 20,000 liters of fenitrothion 50% ULV (FAO/Japan), 60,000 liters of dursban ULV (FAO), 30,000 liters of malathion (USAID/AELGA), 32,000 liters of fenitrothion ULV (EEC), and 8,760 liters of fenitrothion (ODA-GB) were donated, which has been estimated by FAO to be sufficient to treat up to 220,760 ha. In 1988, FAO estimated that only 86,000 ha. were treated. In view of the tentative regional locust plague predictions for 1989 which indicate a locust abatement (the USAID/Chad mission speculated that most of the 1989 locust problems will originate within Chad given the reports of successful control operations in Saudi Arabia), the Chadian request for 600,000 liters of additional pesticides appears to be superfluous. AELGA funds should not be used for the donation of additional pesticides until the present stocks of AELGA donated malathion has been utilized, and an emergency situation is apparent. **It must be emphasized at this point that to react to emergency situations, AELGA must correct its sluggish response capacity to be considered as a donor in the manner prescribed above.** Alternatively, AELGA management may consider the routing of funds to purchase pesticides to an established pesticide bank such as that established by EEC. The EEC pesticide bank, however, is also slow to respond to Chadian needs. While the EEC pesticide bank can deliver stocks within 4 days to any other Sahelian nation, Chad, due to its poor airport facilities in Abeche (and overland transport is a time consuming proposition, too) cannot receive shipments until three to four weeks have elapsed. Another option worthy of consideration would entail the creation of an adequate pesticide bank which could conceivably be facilitated by a parallel "aircraft bank," should AELGA funding permit.

2. Pesticide Selection

The donor community cannot always be described as being responsible about the selection of donated chemicals. (The donor committee in Chad is not headed by FAO, but by the Director of the Ministry of Agriculture who acts under the advice of a technical committee which, until recently, included John Egle, a FAO locust specialist.) In 1988, an FAO-sponsored OCLALAV team brought 3,000 liters of dieldrin into Chad. Fortunately the Chadian government placed the dieldrin in storage and the quantity was replaced with fenitrothion. The French donated lindane, which was distributed around the Lake Chad area and is not intended for use against locusts, which occur farther to the north. Deltamethrin is available (ca. 16,000 liters) and has been used in a limited quantities against locusts. DDVP is not part of the Chadian pesticide arsenal.

While it can be argued that a diversity of pesticides to choose from is optimal for tactical responses to locust infestations, USAID/Chad prefers that the chemical stocks on hand be composed of one compound to avoid the confusion that sometimes occurs when different insecticides are stored in one place. Malathion was promulgated at USAID/Chad even though it is admittedly slow to induce lethal effects in locusts at the recommended rates than alternative (and FAO- and USAID-approved anti-locust pesticides) compounds. Malathion is metabolized by mammals to non-toxic by-products and is less toxic to other forms of wildlife than fenitrothion. Malathion is also less expensive than deltamethrin, and does not suffer from the formulation problems encountered during field operations with carbaryl. (FAO tested a relatively small quantity of carbaryl supplied by Union Carbide within 3 weeks of its arrival, and its viscosity was found to hinder its application.) Water emulsifiable chemicals are not suitable for operation in Chad due to the shortages of water in the regions commonly most plagued by locusts. ULV formulations are unquestionably the formulations of choice because they can be used as they occur in the barrels and because ULV sprays result in more uniform coverage.

3. Pesticide Distribution and Monitoring

Although USAID/Chad was, after about an eight-month lag, able to provide 30,000 liters of malathion to Chad in 1988, the insecticide was stored in Abeche where locust activity has been relatively frequent and intense. Rapid transfer of pesticides to Abeche from suppliers or warehouses located in N'Djamena may be facilitated by the "aircraft bank" concept suggested above. While the malathion donated by the AELGA project is stored in a known quantity and locale, the distribution of other pesticide stocks has been less well recorded. The CPS has been unable, due to its weak managerial and logistical capability, to keep accurate records on the relatively large infusion of donated chemicals into Chad, particularly during the locust crisis. The UNPD/FAO spring 1989 project (with a four year life span and a projected budget of $65 million) includes the provision of a logistician to help improve the ability of the CPS to handle agricultural equipment and pesticides in a more systematic fashion. The UNPD/FAO plan will also deal with expenses for transporting pesticides, spray equipment, personnel per diems, and fuel costs to ameliorate logistical problems. Because the UNPD/FAO project will be of such a large magnitude and will include a broad range of anti-locust related activities, it may be an expedient vehicle for the timely and coordinated application of AELGA funds. It may be possible that specific amounts of AELGA funds placed under the auspices of the UNPD/FAO plan can be targeted for selected UNPD/FAO project activities which conform to the objectives of AELGA.

4. Pesticide Safety

All terrestrial locust control teams have protective clothing. Atropine for injection as an antidote against organophosphate and carbamate insecticide toxicity is available at pesticide warehouses, but training of control teams in its use has not been conducted,

and nurses in Chad are not available for accompanying teams to the field during spray operations in the event of a poisoning incident. All spray crews, however, are equipped with first aid kits. USAID/Chad printed hundreds of illustrated pamphlets on the identification of pesticide poisoning symptoms, but it is doubtful that the pamphlets reached the "lower echelons" in the field, such as farmers and perhaps some CPS ground control personnel. So far, during the current anti-locust campaign, cases of human toxicity has not been reported, even though Chadians do consume locusts and warnings about the advent of spray operations are broadcast over the public radio only (which may not reach nomadic and rural sedentary human populations). Similarly, reports of adverse effects of anti-locust pesticides on livestock have not been recorded. It is highly probable that pesticide toxification has occurred in humans and livestock, but the condition of poor rural and often untracked nomadic peoples in remote northern regions is not often a high priority to national governments, and incidents of poisoning among these populations have gone unnoticed. Although not affiliated with locust campaign activities, the hand application of propoxur dust to the canopies of tall crops did result in the hospitalization of several handlers in 1987.

Because emergency projects frequently include the goal of saving lives, AELGA funding could justifiably be utilized for the training of handlers in pesticide safety precautions under locust emergency conditions, and for developing more far-reaching public warning systems to precede anti-locust treatments. The warning system should include cautions against the consumption of locusts in or near treated areas. In a country such as Chad, where conditions are particularly harsh, and food sometimes scarce, it might be considered inappropriate to advice against the consumption of locusts altogether, but any literature produced or reprinted using AELGA funds should stipulate the possible consequences of eating locusts during anti-locust campaigns. The warning systems should be tailored for illiterate populations, perhaps by placing simple illustrated signs in and near treated areas that depict the potential dangers of consuming locusts there. Thus far, AELGA funding has not dealt with human and livestock safety by the provision of protective clothing, educational literature, or warning mechanisms in Chad. It could seem highly appropriate that the concentration of some AELGA funds be planned for such activities, especially since pesticide poisoning of humans and livestock is a more immediate lethal threat than the presence of locust swarms and hopper bands in isolated areas.

5. Survey

A maxim of locust campaigns is that the efficiency of anti-locust operations is only as good as the quality of existing survey methods. The locust invasions in Chad over the past two years have primarily occurred in the northern regions which are largely uninhabited, remote, and difficult to traverse. In 1989, due to the efficacy of control measures in both Saudi Arabia and North Africa, it was postulated by the USAID/Chad mission that the primary source of locusts threatening Chad would originate within the borders of Chad itself. Whether the 1989 locust swarms come from within or without, effective survey operations are mandatory for the control of locusts that may induce crop damage, or that may cross international borders to breed elsewhere. Since January of

this year, approximately 70 locust swarms of undetermined sizes have been reported in the eastern and central sections of northern Chad.

As these regions begin to dry, locust populations within northern Chad are expected to move south, where moisture will be more abundant. These populations are not likely to breed until June or July; thus, if the swarms are monitored, there will be adequate time to impose control prior to reproduction.

The USGS greenness maps are a very useful tool for identifying areas where locusts swarms are likely to settle, and survey strategies can be tuned accordingly. That the AELGA management did not respond to the USAID/Chad request for greenness maps in January of 1988 can only be interpreted from a strategic point of view as short-sighted. The failure to respond to a request for greenness maps is an indication that AELGA management has been in need of technical assistance. This situation also reflects the inadequacy of the AELGA budgeting structure whereby, although spending ceilings are established on a yearly basis, the total amount is not available for immediate use. In the context of an emergency regional project, this funding structure is inappropriate. In addition to the usefulness of greenness maps for anti-locust purposes, the maps are also useful for livestock management. USGS provides greenness map interpretations that are telexed to the missions. Their interpretations have been very useful in other countries, and should accompany be provided to USAID/Chad.

Survey activities in Chad are considered to be a priority. At present, Chad has only 12 survey teams and 20 vehicles to cover the vast areas of central and northern Chad where locusts commonly occur. There are more radios available than there are teams to use them. Although existing prospection teams have been described as very good, the institution of training programs is essential for the augmentation of available scouts. The training of prospectors should emphasize two general components of survey; i) locust/ grasshopper identification, and swarm size estimation, and ii) standardized reporting procedures. The uniformity of reporting is both a matter of discipline and the availability of standardized report forms which should ideally be instituted on a regional basis (see SURVEY section of this report where interviews conducted at FAO, Rome, were described). The deterioration of OCLALAV has pre-empted its possible application as a regional field survey agency; thus is seems most appropriate that survey activities be the responsibility of the Chadian CPS. In 1987 OSE, funded by OFDA, conducted egg pod survey in Chad and was successful in predicting that locust outbreaks were imminent. Due to the success of the 1987 egg pod surveys, the John Egle report indicated that egg pod concentrations were divided into four zones within Chad, but were quantified for entire political areas rather than described as point data. The species which had deposited the eggs were not identified in the report. Egle, however, did indicate that there were extensive areas of high egg pod densities (maps were included) in January and February of 1988. It was also noted that density-dependent parasitism and predation of the eggs may account for a 20% reduction in viable eggs in some areas.

The proposed UNPD/FAO plan for renovating the Chadian CPS will include training for CPS personnel. AELGA funds may possibly be channeled for the distribution of

standardized FAO locust report forms on a regional basis. Such an application of AELGA funds would benefit a fundamental priority in any locust campaign, and would conform to the regional definition of AELGA.

The inhospitable terrain of northern Chad poses a difficult problem to ground survey teams. Prospection activities are at once slow and dangerous to the scouts. Most surveillance is conducted near roads and traversable tracks such that control operations are generally confined to areas that are accessible to vehicular traffic, which is a limitation to notions of imposing truly strategic locust control tactics. In addition, all roads in northern Chad are considered to be open only when climatic conditions permit, and unpredicted rains can strand survey teams in remote areas. In one recent incident, a two-vehicle survey team was isolated in and an uninhabited site following the arrival of the rainy season for 2.5 months until they were finally rescued by a French helicopter. It is fortunate that Chadian scouting teams are all composed of two vehicles, a radio, and camping gear at the insistence of the survey personnel themselves.

To investigate remote regions of northern Chad, aerial survey craft have been employed, mainly as donations from other countries. It may be relevant to cite an anecdote regarding donated survey aircraft to illustrate the potential problems that can arise due to poor utilization and decision making on the part of surveyors who are sent to assist Sahelian nations from donor countries. In the fall of 1988, OFDA funded the use of survey aircraft to verify consistent CPS reports of locust swarms near the 16th parallel. The FAO prospectors, however, failed to investigate the area and instead flew to regions where there was no reason to believe that locusts were present. After two missions to the areas which did not include the 16th parallel, the aircraft returned to the N'Djamena area. By the time an OFDA financed Belle 206 helicopter was able to survey the 16th parallel, the swarms had moved elsewhere and were not to be found. This indicates a need for creating a mechanism by which the donors of aircraft can have more control over the implementation of the survey units. The previously described incident has resulted in a reluctance by the Chadian CPS to call upon FAO for future prospection activities. USAID/Chad tends toward the regional approach to prospection, yet indicated that it could more effectively conduct aerial survey programs but cannot due to budgetary and personnel constraints. Joint country agreements (i.e., between Chad and Niger) could be suggested as an alternative to broader regional programs (which presently are nonexistent with regard to field scouting). A joint country approach would entail careful negotiation between the involved nations regarding the sharing of resources. Countries such as Chad, Niger, Mali, and Mauritania must conduct survey operations on a continuing basis, which may provide a rational for the joint country concept. The Chadian CPS has envisioned the institution of a five year surveillance project to fill the void left by the dissolution of OCLALAV field prospection activities. As the joint country approach is now merely an idea, it is doubtful that AELGA, given its short life span, can contribute to the actualization of such an endeavor. AELGA funds, however, could be applied toward the strengthening of Chadian survey resources though the provision of training either unilaterally or through FAO, fulfilling the request of USAID/Chad for greenness maps, distributing standardized survey reporting forms, and by supporting aerial survey efforts if a mechanism for the control of the donated aircraft is identified.

6. Aerial Application

In Chad, crop protection tactics against the desert locust has not been identified as a major issue. Since swarms are primarily treated in non-agricultural areas, control is sometimes referred to as being "strategic." The efficacy of "strategic" control tactics in anti-locust operations will, and has been, dictated by i) the quality of survey methods, and ii) the effectiveness and decision making processes inherent to chemical application. Both the effectiveness and decision making processes rely upon available technology and knowledge regarding its prudent use. For this, training is fundamental but will be discussed under a separate heading in this manuscript.

Although regional control agencies have been a topic of discussion for concentrating the resources of cooperating nations on key areas, the weaknesses of such an option include vehicles for funding in the absence of established control institutions, and the control of funds by donors to insure their judicious use. An alternative to the regional program approach would be to encourage more limited joint country agreements (i.e., Niger and Chad, as described under SURVEY) by which locust control resources could be shared after negotiations regarding allocation of the resources have been forged. This concept has some precedent; in fall 1988, Algeria conducted limited spray operations across its borders in northern Mali to eliminate the imminent arrival of swarms. If such an approach were to be adopted by Sahelian nations inclusive under AELGA, the provision of AELGA funds could support technical assistance (i.e., entomologist, logistician) on limited contracts devoted to the joint efforts of the countries involved. USAID missions within the cooperating nations could similarly contribute toward the joint effort. While aircraft are supplied by other donors (six aircraft and ca. 575 flight hours were provided by donors to Chad in 1988), the US has been a major contributor to aerial operations. If the US were to curtail its aircraft donations, the aerial fleet available in Chad during 1988 would have been reduced significantly, especially when the two of the fixed wing aircraft donated by the US were of highly approporiate for the locust operation (Turbo Thrushes). The AELGA project could be directed toward funding aerial spray craft when OFDA funding should be used for pressing, short term disaster scenarios. In addition, another avenue for AELGA spending could be the strategic identification and construction of airstrips in remote areas that cannot normally be reached by small aircraft other than Turbo Thrushes. A regional effort could be initiated to identify and/or improve strategic airstrips in remote areas such that treatment operations can be conducted in previously inaccessible areas.

7. Ground Application

The Chadian CPS has at its disposal 20 vehicles for survey and ground treatment operations. The spray vehicles are 4X4 Toyotas, 12 of which have been fitted with Swiss-donated ENS systems. (Tifa foggers are not looked upon favorably in Chad because they are more difficult to maintain and calibrate.) There is a need, then, for additional ENS systems along with the augmentation of existing teams. Hand sprayers have been supplied by donors (in 1988, 600 backpack sprayers were donated by France

and CARE, and 50 atomizers were supplied by CARE). Because backpack sprayers are frequently utilized by farmer brigades (which the FAO/Chad report claims have been formed: 1,000 brigades composed of 10,000 farmers. The USAID/Chad mission is skeptical regarding this FAO assertion), training is mandatory at the field level. The proposed UNPD/FAO four year plan (budget estimated at $65 million) should be the method by which such a massive undertaking is instituted. It is unlikely that AELGA funds could be applied toward ambitious farmer brigade plan, other than to contribute toward training in a limited way (to be discussed in Section 10, Training and Incentives).

8. Pesticide Storage

In Abeche, OFDA funded ($8,000) the construction of a storage warehouse for 50,000 liters of pesticide. The storage facility is a ventilated tin shed with a concrete floor. The barrels are placed on 4X4 boards, and the shed is kept locked (USAID/Chad has a key). USAID/Chad indicated that the concentration of funds for developing additional storage facilities would be superfluous in light of the relatively small quantities of pesticide and few prepositioning sites on hand. The construction of more storage facilities, however, will be necessary should strategically located airstrips be created in remote areas. Although the storage facilities at these emergency airstrips would be used temporarily and only during ongoing locust control operations, they would nevertheless have to be secure from local populations and of similar quality (but not size) to the warehouse that was built in Abeche. AELGA funds have not addressed the issue of pesticide storage facilities in Chad, and in light of the proposed UNPD/FAO project, this contingency may not be necessary.

9. Disposal of Unusable Stocks and Empty Drums

In 1987, empty malathion and fenitrothion barrels were systematically punctured, doused with fuel, burned, crushed, then buried in desert areas with a low water table. The use of bulldozers was obtained without charge from various agencies and private firms operating within Chad for the excavation of drum disposal burial sites. Although the locust campaign has doubtlessly compounded the problem of accumulating empty pesticide drums, it is a matter of debate as to whether or not the disposal of such drums should be considered within AELGA's emergency context. It would seem more appropriate, should AELGA direct its attention the pesticide disposal problem in Africa, that funding be specifically targeted toward the disposal of the existing 3,000 liters of dieldrin presently stored in Chad. Due to the lack of adequate pesticide disposal technologies within the Sahel, it would seem that a regional disposal strategy be addressed by the Sahelian states whereby central international disposal facilities be constructed to alleviate this mounting problem. Since FAO is reluctant to become involved in the pesticide disposal issue beyond its published Code of Conduct, it is unlikely that FAO would be amenable to expanding its role in this regard. If AELGA management considers the pesticide disposal issue to be appropriate within its emergency context, then funding may be set aside as an incentive for Sahelian nations to cooperate in pesticide disposal actions as a regional operation or for joint nation cooperatives.

As yet no pesticide spills have been reported from during the present locust resurgence. The contingency plan, as described by USAID/Chad is to remove contaminated soil from spill sites and to bury the soil in the desert. Stocks of lime to neutralize organophosphate and carbamate spills are nonexistent. Spills on concrete are washed down with soap and water, which is not an ideal method of containing pesticide accidents. While potential pesticide spills may not be a priority issue under the emergency context of AELGA until the spills actually occur, the incorporation of pesticide management within AELGA technical assistance provisions to Sahelian nations may be appropriate, particularly if the item is merely added to the consultant's scope of work. Any applied entomologist should be familiar enough with pesticide management such that the addition of this responsibility would not present an undue burden.

10. Training and Incentives

In the view of both USAID/Chad and the Chadian CPS, those Chadians who have been trained can perform their functions in agricultural matters satisfactorily. There are basically two concerns that have been identified with regard to the issue of training. The first is that the CPS suffers from administrative weaknesses, and that managerial reconstruction should be regarded as a key focus of future training programs. The UNPD/FAO will initiate such a project as part of its sweeping four-year plan. If the plan is effective, it should help to stabilize the inevitable chaotic logistical conditions inherent to crisis management. Chad's limited CPS staff, which consists of only four "engineers" (the rest are classified as "technicians") will be strengthened by the addition of three UNPD/FAO project funded logistics and entomology specialists. A strong management can be perceived as an incentive for engineers, technicians, and field personnel to perform their duties conscientiously and to motivate learning.

Second, although educational programs have been successfully conducted for agricultural trainers, funds are currently unavailable for these individuals to disseminate their information to field personnel. FAO, however, claims to have provided training to create 1,000 farmer brigades composed of 10,000 farmers. Additional training measures will be covered by the proposed UNPD/FAO four year plan. At the farmer brigade level, training should include L/G identification, proper use of pesticides and equipment, reporting methods, swarm density estimation, and L/G biology and behavior. In light of the UNPD/FAO project, AELGA funds do not seem to be applicable to training either at the administrative or farmer levels.

"Superficial" incentives incorporated into training packages are of dubious value in Chad given the reported willingness of the Chadians to learn of their own volition. Crop protection and firm supervision appear to be the best modes of providing motivation.

11. Environmental Concerns

Formal attempts to conduct environmental monitoring studies in Chad are nonexistent, and no plans for such activities are envisioned. The Chadian CPS and government, however, are conscious of environmental concerns: witness their immediate impoundment of donated stocks of dieldrin, and their adherence to FAO recommended anti-locust insecticides. In the past, dieldrin has been sprayed over large areas in the remote north of Chad, and after lethal effects on wildlife were noted, the Chadian government responsibly discouraged the use of such long-residual and broad spectrum insecticides for agricultural use.

C. MALI CASE STUDY

1. Background

USAID/Mali has developed a three level scenario for dealing with future locust infestations. Each level has been defined in terms of the following parameters: i) crop area infested, ii) duration of the campaign, iii) extent of donor participation, and iv) required funding. At each level, USAID/Mali is assuming that the invasion will be beyond the capacity of the Malian CPS to control with its own resources. A breakdown of USG funds for the Malian L/G campaign is provided in "Long Term Locust/Grasshopper Control Program" by Mamadou Fofana. Expenditures on L/G control efforts in 1986 and 1987 were each approximately $1,100,000, but the amount doubled in 1988 to about $2,330,000. The three levels of the 1989 USAID/Mali plan are outlined as follows:

Level I presumes a crop area infestation of 200,000 to 300,000 ha, mostly in western Mali where the potential personnel base permits the mobilization of a ground campaign. The threat in Level I is characterized as "localized" in that swarms would not necessarily impinge upon neighboring nations. The total cost is $6 million, of which Mali is expected to contribute $1 million, and other donors are expected to provide the remaining $5 million. USAID/Mali is prepared to provide $500,000 from the bilateral OYB ($300,000 unearmarked in the L/G project are presently available, $200,000 to be taken from the 1989 OYB).

Level II presumes a crop area infestation of 500,000 ha. or more with the potential of swarm migration to other countries. These infestations would likely be initially located within the 15th and 16th parallels along the Mauritania border, the central delta area, and the region south of the Mauritania border, as well as the Adrar des Iforas breeding grounds. This campaign would last six months or more. The total cost would run some $8 million of which donors are expected to provide $7 million. The Level II campaign will require aerial operations in crop areas. AID would expect to contribute $1 million and USAID/Mali would intensify its support of operations for crop protection to assist aerial spraying (including flight time, pesticides, logistics support). The USAID/Mali

mission would contribute its unearmarked $500,000 and additional $500,000 from deobligation of funds and additional funds from AID/W.

Level III presumes a crop area infestation of more than 500,000 ha. and the obvious threat of swarms moving to neighboring countries. A Level III outbreak could involve a 10 - 20 percent crop loss scenario. Like the 1988 Senegal campaign, a Level III infestation would overwhelm both Malian and donor efforts, and would represent a "regional emergency." The duration of such a campaign is unknown. The cost would exceed $10 million for support in all aspects of locust operations. USAID/Mali could contribute a maximum amount consistent with that described for a Level II campaign.

In the event of Level I, II, or III infestations, USAID/Mali intends to focus its attention on supporting ground operations for crop protection purposes, and has indicated that FAO, OFDA, OCLALAV, and other donors address aerial operations and areas of "strategic" importance (ie.e., Adrar des Iforas). In the view of this evaluation team, AELGA funding could be constructively utilized to support ground operations with the continuance of greenness map provisions, and technical assistance to renovate logistical support measures. (Other suggestions for the use of AELGA funds in Mali are discussed elsewhere in this manuscript under separate headings.) It is imperative to state here, however, that the traditional breeding grounds in the Adrar des Iforas should not be neglected by USAID/Mali and AELGA funding could be applied toward strategic control efforts. The notion that such breeding grounds are ultimately the problem of neighboring nations is a dangerous and short-sighted: it ignores the regional nature of locust resurgences. Those nations that harbor breeding areas should take first responsibility for imposing control measures upon them, and these nations should permit neighboring countries to conduct cross-border operations to protect their own interests. While the USAID/Mali mission believes that FAO is the logical coordinating institution for AELGA funds due to its depth and breadth of experience since 1952--and it is undeniable that FAO should take the lead in donor coordination--this evaluation team would stipulate that AID maintain control over the funds granted to FAO in light of the problems encountered in the recent past. The AELGA evaluation team suggests that a mechanism be established to implement some degree of AID control over funds granted to FAO, or that AELGA funds be provided directly to the missions to be utilized bilaterally or in conjunction with other missions or donors where nations have agreed to pool their resources and efforts in a more regional or concentrated country-specific attempt to combat L/G infestations.

The AELGA-sponsored technical assistance wherein George Popov was contracted to visit Mali (6/19/88 - 12/4/88) was primarily geared toward locust and egg pod surveys, identification of donor contributions, and the production of recommendations to strengthen the Malian CPS for future locust onslaughts. In his report, Popov provided a summary of the 1988 locust campaign in Mali. He noted that: the response to the initial invasions was slow; there was a lack of pilots; and, the impact of ground intervention was limited. By late June, farmer militias were organized and egg pod fields located. The farmer brigades were quite effective, and were successful in destroying many of the egg pod fields before the eggs had enclosed. Those eggs that were able to hatch produced swarms that were combatted by farmer brigades, CPS

teams, and a military detachment. Approximately 5,000 hac. of hopper bands were eliminated, and three Sikorsky helicopters were utilized to destroy residual swarms. By early August the helicopters had applied fenitrothion to approximately 11,000 ha. By mid-August, eclosion of Senegalese grasshoppers was reported from the Kayes to the Nara areas; control was effected by ground and air using the three available CPS fixed wing aircraft and two CIDA (Canadian International Development Agency) aircraft. During the next month and a half, 20,000 ha. were treated. By this time, the donor community was augmenting the anti-L/G efforts, and logistical problems were encountered as the Senegalese grasshoppers commenced to breed. Three fixed wing aircraft and two Sikorsky helicopters based in Bambara-Maounde, in addition to ground control teams were summoned to treat the swarms which nevertheless spread northward into the Adrar region. From mid-October to mid-November second generation Senegalese grasshoppers enclosed and spread to the Adrar, Temessna, and Timetrine areas, large bands invaded the Nampala region from Mauritania, and more were observed in Lere and Timbuktu in addition to the areas of their origin. Control measures to protect the crops were considered successful, but many swarms escaped. Treatments were conducted using a Bell survey helicopter, two Sikorsky helicopters, a BNI, and two PA25s. Logistical problems were not as serious as before. But these aircraft were not utilized at the outset of the grasshopper resurgence, and treatments were primarily conducted in the Adrar to eliminate late instars and fledglings. By mid-October, additional grasshopper influxes occurred, and ground operations continued with moderate success for crop protection. The aircraft were all removed from the campaign, and in November, the two Sikorsky helicopters broke down.

Because Malian control operations were essentially targeted toward crop protection, the effect of these efforts on overall L/G populations were not substantial. Breeding of the desert locusts in the Adrar des Iforas and the Senegalese grasshoppers in the Sahelian savanna are still in need of attention. Both the CPS and USAID/Mali have indicated that, with particular reference to the Adrar des Iforas, strategic operations should be a multilateral responsibility, and funding for such efforts should originate entirely from the donor community. As will be pointed out in the sections of this report on Niger and Mauritania, ground operations should be mobilized and logistical considerations should be accounted for prior to the next L/G episode. Aerial equipment should similarly be deployed for strategic intervention. The USAID/Mali perspective is that all three levels of L/G infestation in the recessional breeding grounds should be dealt with under the jurisdiction of a regional or international agency. The Malian Adrar des Iforas is considered a recessional breeding ground, which, until this year, was the responsibility of OCLALAV. Successful breeding in the Adrar des Iforas combined with a lack of control will have ramifications that reach beyond the political borders of Mali. This is why Mali and USAID/Mali considers that Adrar des Iforas to be a regional problem. USAID/Mali has stated (cable 00800/01 dated 2/6/89) that "responsibility for intervention rests with AID/W (OFDA and AFR Bureau, presumably in coordination with FAO and other international and regional resources)." It seems that, given the projected decline in locust activity for 1989, the financial burdens placed upon OFDA by intrinsic disasters (as defined by AID/W), and the dubiousness of locust infestations being classified as being emergency/life threatening circumstances, the role of OFDA should be minimized, and counterbalanced by strengthening the capacity of AID/AFR

(and AELGA) to deal effectively with rapidly developing situations. The reorganization of responsibilities within AID/W should be accomplished in tandem with the vitalization of national CPSs, limited coordination with FAO, the continuation of donor committee activities, the institution of a viable and flexible pesticide bank (and, if possible, an airplane bank), and the encouragement of political and material cooperation among the afflicted African states.

The USAID/Mali mission has strongly indicated its appreciation for AELGA in providing malathion, the technical assistance (Popov), and greenness maps. The mission hopes that the AELGA project will be extended beyond its current three year life span. USAID/Mali, however, wishes to know what funding will be made available for L/G efforts such that it can help the CPS to plan for 1989 activities.

2. Pesticide Selection

In 1988 approximately 300,000 liters of pesticide were used, and now the CPS has only 250,000 liters of AID-waivered insecticides for the 1989 campaign. Additional stocks are needed mainly to circumvent logistical problems by prepositioning adequately such that each operational base will have enough on hand during the 1989 L/G campaign. At present, the Malian CPS has prepositioned 70,000 liters in the Adrar region, despite the claims that strategic control is a multinational responsibility. Fenitrothion, however, is clearly the CPS's pesticide of choice due to its availability and its efficacy. The CPS, however, is reluctant to be specific in requesting pesticides, and will accept whatever is donated. The CPS has indicated that it is difficult to make rational decisions on pesticide selection issues due to the lack of scientifically produced environmental data. The CPS for 1989/90 wishes to add 600 tons of 5 percent fenitrothion dust and 2 percent propoxur dust to its arsenal in addition to 400,000 liters of EC and ULV insecticide formulations. Although the propoxur dust is in the greatest demand, AELGA, in conforming to Waiver 16 regulations, could contribute to the need for additional malathion ULV to augment Mali's malathion stock of at least 70,000 liters stored in Adrar. Malathion ULV, if made more available, would be employed with alacrity by the CPS as malathion is recognized as being more environmentally sound than fenitrothion. The fact that malathion does not produce rapid locust kills is not viewed as being a detrimental aspect of the insecticide.

Although the organophosphate insecticides are preferred in Mali, their short residual is a drawback as, in breeding areas, certain sites have been sprayed up to seven times during one campaign when locusts continue to reoccupy the same place. While propoxur dust was used extensively by rural farmers, its relatively short shelf-life was a drawback as portrayed by often poor locust kills. Propoxur dust, however, is the mainstay of the farmer brigades, and stocks have been depleted since 1988 such that additional quantities are necessary for 1989. Deltamethrin was identified as being expensive and, although it results in quick knock-down, the L/G too often recover and have to be re-treated with another insecticide. It may be worthy of note that the FAO recommended testing "pesticide cocktails" that consist of a pyrethroid insecticide mixed with malathion or fenitrothion to provide rapid knock-down and kill. While no reports of wildlife toxicity

after fenitrothion and malathion treatments are known, fenitrothion (and diazinon) were found to be phytotoxic to sorghum. BHC, lindane, and dieldrin are not used, but are on stock. The French and Algerians were responsible for donations of lindane (10,000 liters), even though these insecticides were not requested and were immediately impounded. French and OCLALAV donations of dieldrin (50,000 liters) were similarly impounded. DDVP has been donated by Algeria and impounded in Mali. As with lindane and dieldrin, the CPS will utilize the DDVP in a crisis situation, while cognizant of its hazards to humans, wildlife, and other nontarget organisms. The CPS indicated that, in particular, lindane and dieldrin will be employed as a last resort if alternative insecticides become unavailable. The issue of the stocks of long-residual organochlorine insecticides in Mali will be discussed in Section 9.

Bait formulations have not been used in Mali to any appreciable extent, but will be tested during the 1989 campaign. Baits would be a logical choice for farmers to use for crop protection purposes against L/G bands, but the current fear is that livestock will consume bait formulations. Rice bait base treated with carbaryl has been suggested by the Malian CPS as a possible choice for bait formulations.

3. Pesticide Distribution and Monitoring

Crop damage is largely attributed to a lack of pesticide availability. Logistical problems such as the movement of insecticide stocks from one operational base to another are also perceived as a concern due to i) the difficulties imposed by terrain, ii) occasional fuel shortages, and iii) the lack of record-keeping. (There are no up-to-date inventories of stocks at each operational base.) Another item of concern, which also begs the importance of pesticide prepositioning is the transport of donated pesticides from littoral countries to inland nations such as Mali, if the stocks are loaded from donor countries onto seagoing vessels. The concept of the "aircraft bank" as proposed elsewhere in this report may be expanded to encompass transport aircraft for rapid movement of equipment and pesticides. Both the CPS and the USAID/Mali mission have expounded upon the importance of obtaining technical assistance specific to logistics (which could be utilized on a regional basis prior to the onset of L/G infestations).

The AELGA project, in March 1989, provided the CPS with 50,000 liters of malathion to be prepositioned by train to western Mali for use against grasshoppers. Both the CPS and USAID/Mali emphasized that the malathion arrived in a timely fashion for the successful treatment of the grasshoppers.

4. Pesticide Safety

The concern for pesticide safety in Mali is notable; however, the needs for additional safety equipment and training are great. In 1988 there were no reports of human or livestock toxification due to the anti-locust spray campaign. The CPS related the following anecdote to illustrate the need for developing safety precautions and pesticide poisoning diagnosis and treatment. A pesticide applicator had been spraying

fenitrothion, and at the end of the day, after a shower, he was drinking tea with his co-workers. To the astonishment of those gathered, flies which had been settling on him were falling to the floor, apparently in response to the insecticide residues on the man's skin. The man continued to shower each day, but the flies continued to die for an entire week. The CPS director sent the man to the hospital even though he showed no overt signs of pesticide poisoning. The doctors were unsure as to how to test or treat the man. As a result of this incident the CPS has requested that a pesticide health seminar be arranged for the Ministry of Public Health and the CPS employees. USAID/Mali has agreed to help coordinate and plan the seminar, and it seems appropriate that AELGA funds be applied toward this worthy endeavor. The provision of literature and visual aids, in particular, are needed for the effective dissemination of information on the proper application of pesticides, and the different types of insecticides and their symptoms, prevention of poisoning, and treatment. The Red Cross intends to conduct health studies and cholinesterase testing; the CPS, further, expressed an interest in obtaining currently unavailable cholinesterase test kits for personnel to do field checks. This project could conceivably be performed in conjunction with the aforementioned pesticide safety seminar proposed by the Malian CPS and USAID/Mali.

At present, protective clothing (three tight weave cotton coveralls are provided for each control agent, and paper masks are in supply along with boots, goggles, and gloves) is not commonly worn by applicators, loaders, and handlers due to the heat. The control teams have first aid kits, injectable atropine, and a skin cream (could be vitamin E but the tubes of the cream did not bear ingredient labels) presumably to alleviate skin irritation caused by many pesticides. CIDA, in conjunction with the Malian CPS, intends to test a local fabric for new coveralls which may prove more practical for the hot weather conditions in the Sahel.

Another safety problem is the scarcity of water in the field for washing immediately after pesticide applications. It would seem judicious for ground teams to carry a sealed container of water on all operations for the purpose of post-application washing.

The warning system to local populations prior to L/G treatment operations is primarily by word of mouth from CPS personnel; people are told to cover their water and food stores, and not to enter the application sites for several days. Undoubtedly, the warnings do not reach all people in light of the various nomadic tribes that inhabit Mali. The health seminar proposed by USAID/Mali and the CPS should include the development of an effective warning system that may involve posting illustrated signs in treatment areas such that illiterate populations can benefit from the intent of the messages. The CPS indicated that locusts are not considered a dietary item in Mali, but this evaluation team has reason to believe that such an assertion may not necessarily apply to the often ignored nomadic peoples.

5. Survey

Greenness maps are highly valued in Mali and AELGA should continue providing them. They have received extensive use for conducting efficient survey operations. The egg pod surveys and swarm activity monitoring of George Popov in 1988 is perceived by both the Malian CPS and the USAID/Mali mission as very valuable.

Survey, communication, and logistical support to remote bases of operations are frequently constrained by extenuating conditions that occur during the monsoon rains. This is yet another rationale for the CPS's decision to restrict its anti-L/G campaign to areas of crop production only. Aerial surveys, however, have been effective (i.e., work performed by AID consultant Ian McKay and chief OCLALAV prospector Moussa Coulibaly) in locating areas of infestation.

The twenty ground prospection teams (FAO has agreed to add three more teams for the Adrar region) consist of one 4X4 vehicle with a chauffeur and an experienced scout. Standardized reporting forms are provided; separate forms exist for i) egg pod surveys, ii) swarm movement records, and iii) treatment operations. The forms are largely based upon FAO reporting forms, but like the FAO forms, weather data are not included. Each team also carries a radio set (ground-to-ground which transmits to fixed stations that in turn transfer messages to Bamako), a motorized sprayer, and at least one workman. Sixty thousand dollars has been spent on radio equipment for ground teams; there is no lack of radio equipment, and Mali is attempting to standardize its radios. The survey units operate in delineated geographical zones and are sited at main bases or observation posts between prospection forays. The CPS indicated a need for more survey teams; the chief limitation is the number of experienced scouts; obtaining more prospection vehicles is of secondary importance. The CPS is more than capable of training additional scouts; OCLALAV or FAO survey training would be superfluous. Augmentation of survey personnel would also alleviate the present burden assigned to each existing team (200 - 300 square km per day).

Aerial survey methods could be made more efficient by improving aircraft prepositioning tactics. The aircraft should be assigned to air strips that are suited for the type of aircraft. If a particular airstrip is known to be unusable to fixed wing aircraft for a large part of the time due to excessive soil moisture, then helicopters should be the aircraft of choice in these areas. The 1988 George Popov trip report adequately discusses the capabilities of various aircraft commonly used in locust campaigns. As noted in the Chad section of this report, AELGA funds may be channelled toward the partial funding of an "aircraft bank" through which affected Sahelian nations could choose from an available arsenal of aircraft types.

Survey aircraft, during known plagues within their respective zones of operations, should fly with loaded insecticide tanks to treat bands and roosting swarms as they are located. Aircraft fuel is a major issue in aerial operations. Because the assemblage of aircraft consists of numerous types, three fuels are necessary: avgas, jet, and diesel. Aircraft fuel should be prepositioned at aerial operations bases in sufficient quantity for the projected intensity of control efforts, and the fuel should correspond to the specific aircraft

stationed at each base. Now that the avgas and jet fuel is in short supply as a result of 1988 operations, diesel-using aircraft, such as Alouette helicopters, should be considered for future donations. In addition, the fuel on hand is stored in undifferentiated barrels which can be easily confused. Problems distinguishing among the fuel types have been encountered in Mali. Shortages of fuel barrels has also been identified as a weak link in aerial operations. Many of the pilots refuse to fly without new tanks and this has hindered the aerial campaign in the past. This discussion applies to spray aircraft as well. AELGA could contribute toward the alleviation of these problems by responding to the need for additional fuel and barrels for 1989, and by providing short-term technical assistance for logistics, especially where aerial operations are concerned. The technical assistance should be instituted prior to the actual onset of emergency conditions so that prepositioning of materials (fuel, spare parts, and insecticides) can be performed to maximize the CPS and donor response capacity. The technical assistance consultant could conceivably operate on a regional, rather than a country-specific basis. It should be emphasized that logistical concerns are a priority matter in Mali and must be addressed accordingly. The regional survey option should be enhanced by CILSS, which could develop its political role to address the subject of cooperation on surveys among the affected states, which is presently hindered by international disputes. Thus far, the only example of cooperation among Mali and its neighboring states has been with Algeria, which conducted ground operations in northern Mali to mitigate locust arrivals into Algeria (Fall, 1988).

6. Aerial Application

While much of the anti-L/G campaign in Mali was conducted by ground in 1988 (see following section on ground application), it became evident that the infestations were beyond the scope of terrestrial spray teams. The following aircraft were available to the Malian effort; one BN Islander (CPS), one PA25 (CPS), one PA25 (French Cooperation), one Bell 4762 helicopter (USAID/OFDA and French Cooperation), two Sikorsky S55T helicopters (Stromme Foundation and GTZ), one Sikorsky S55T helicopter (Norwegian Church Aid), and two Turbo thrushes (CIDA). All were equipped with micronaire sprayers except one fixed wing aircraft which had a ram spreader. The utility of the ram spreader suffered from its difficulty to calibrate. The micronaire sprayers were all calibrated prior to their use for volume output on the ground and during flight, and by measuring droplet diameters using cards. Some aircraft have separate flow meters for each micronaire to record pesticide output over time to implement the calibration process. The CPS indicated that the CPS aircraft were not always used effectively partly due to pilot assertions that the planes were unsafe, and, at the Bamabara Maunde airstrip (where all the aircraft were stationed save for the Turbo thrushes), wet conditions frequently caused the Islander and the Pawnees to be grounded. Lack of fuel in the Niafunke area complicated aerial operations there, and infestations in the Gorgando and Faguibine regions were not treated as a result.

The CPS indicated that all aircraft were equipped with air-to-ground radios, but that the Malian pilots were often reluctant to use them for unspecified reasons. Nonetheless this was not considered a problem.

The Popov report stated that the two CPS aircraft and the Bell helicopter were often grounded as a result of logistical and mechanical deficiencies. The Sikorsky helicopters guided by OCLALAV scouts were highly effective until they broke down on the 25th of November, 1988. The 1988 aerial campaign resulted in the treatment of 41,840 ha.

The CPS uses aircraft and determines rates of pesticide application by factoring in all of the following criteria: windspeed, temperature, L/G life stage, proximity to crops, and vegetative height. Aircraft are primarily employed to control L/G for crop protection; ground treatments are preferred in "less critical areas." Given proper timing for prepositioning and the subsequent strengthening of ground operations (including farmer brigades), this approach should actually be reversed. Ground forces should be mobilized early to prepare for crop protection efforts, and aerial resources should be largely employed to deal with strategic locust control and survey.

Were the AELGA project to contribute toward the amelioration of aerial operations in Mali, it should be in the form of technical assistance to develop a strategy by which aircraft can be used to maximum advantage. Considerations must include fuel availability and logistics, appropriate choices of aircraft given the previously described airstrip conditions, calibration techniques, the proper application of the pesticides, and pesticide loading and handling procedures. This technical assistance could operate on a regional basis. The concept of an "aircraft bank" should be encouraged.

7. Ground Application

The total area treated by ground in 1988 was approximately 400,000 ha. Because the primary objective of the CPS was crop protection and the destruction of hopper bands, ground operations using 45 farmer brigades were utilized as a major component of the control efforts, and these farmer groups received high praise from all parties. Their effectiveness in 1988 was partly due to their acquired experience from the 1986 and 1987 campaigns. In the Sekou Diabenta region alone, early instar hoppers were eliminated over a 120,000 ha. area by treating only 400 ha. This early intervention by local farmers prevented a probable expansion of the infestation to 10,000 ha. actually settled by L/G. In other instances, according to the CPS and the Popov report, the farmers were not adequately trained or equipped but still managed to prevent crop losses by timely intervention against early instars. Hand or backpack sprayers with 3 PC and 5 percent fenitrothion EC and ULV formulations were used by farmers with experience, and dusters and dusting bags were utilized by rural, untrained farmers. Approximately 30,000 ha. were treated by farmers in 1988. Because rural farmers are commonly used to combat locusts and grasshoppers using propoxur dust formulations, additional supplies of backpack sprayers are either not necessary or can be provided by other donors. (The CPS did not indicate a shortage of backpack sprayers.)

According to the Malian CPS, the ENS is the best vehicle- mounted spray system as it is easy to maintain and operate. Thirty ENS are now available for use in Mali, having been donated at the end of 1988. As in most other nations that utilize the ENS,

shut-off mechanisms internal to the cab should be constructed to avoid the driver having to physically remove himself from the truck to manually turn the machine off. While this point of criticism should be addressed as a general recommendation, it is simple to remedy and need not be corrected using AELGA funds. The other conventional vehicle-mounted sprayers are more difficult to maintain and calibrate, and are more expensive than the ENS system. The CPS did not indicate a particular need for more vehicle-mounted sprayers. The CPS in Mali has twelve unimog trucks and two 4X4 light vehicles. Ideally, to match the number of ENS systems, the CPS should have at least 18 more unimogs or light 4X4 vehicles, but this need should be passed on to other donors which have donated such vehicles in the past. Other donors, too, should provide short-term technical assistance on the use of the ENS; the British or the Jordanians may be of service in this regard.

In terms of AELGA, ground application equipment and methods should not be a high priority, unless the AELGA project was to fund short-term technical assistance on a regional basis to help train farmer militias in rural areas.

8. Pesticide Storage

Pesticide storage conditions in Mali are variable, and do not often have cement floors even when shelters have been constructed. Security measures are lax or nonexistent. Small spill areas are common within storage compounds, and many stocks of insecticides are kept in unfenced and open sites (including the storage site in Bamako); thus Mali is in need of improved and additional storage facilities. The OCLALAV storage facility in Adrar is a shelter with a dirt floor; OCLALAV has turned the site over to the CPS, which has subsequently requested that USAID/Mali provide funding to construct a fence around it. This consideration, however, is not a high priority item to USAID/Mali.

The UNDP project (as described in the section on Training) has budgeted $500,000 to build offices and storage facilities at each of the eleven phytosanitaire stations and at additional operations sites. Fencing, water supply, and lodging or security are not part of the plan. Thus, AELGA funds can be applied, in conjunction with the UNDP project, toward providing these items so essential for creating adequate and safe pesticide storage facilities.

9. Disposal of Unusable Stocks and Empty Drums

Disposal, like storage, is a significant problem in Mali, as there are large stocks of undesirable insecticides (i.e., lindane and 50,000 liters of dieldrin) and empty pesticide drums are frequently used for other nonprescribed purposes. The problem of empty drums exists at all levels of the campaign; the barrels that are in relatively good condition are used as tanks for fuel and other pesticides. A problem typical of many nations is the location and collection of empty barrels from the field after each campaign. The CPS has been requesting that each phytosanitaire base collect the empty barrels in its region so that, at the end of each campaign, the drums can be

concentrated at disposal sites. While this plan appears to be a conscientious effort to ameliorate pesticide waste accumulation, there is nevertheless no plan for the ultimate destruction of empty drums and stocks of undesirable pesticides.

Most of the dieldrin on stock is in Gao, stored in the open on bare ground where there is a low water table. There are also more than 2,000 to 3,000 liters of dieldrin and lindane stored in Adrar; the stocks are reportedly quite old and are stored in the open on bare soil; the water table is reported to be relatively high. The CPS has set a high priority on the destruction of the unwanted quantities of dieldrin and lindane, and concern over the possibility of pesticide leakage is mounting. At this time, however, the methods and facilities for the destruction of unusable stocks are unavailable. Those nations that have donated stocks of lindane and dieldrin are unlikely to repossess their unrequested donations. Thus this is a problem which Mali must face with the possible assistance of other donor support. In addition to the stocks of lindane and dieldrin, there exist eight tons of propoxur wettable powder in Bamako which is over three years old and which was not previously used because of formulation problems. It is within the purview of AELGA to deal with nonwaivered insecticide stocks for containment and destruction processes. AELGA management should take action to provide unbiased and highly qualified technical assistance to Mali (or to rove among the Sahelian nations) to specifically aid in developing plans for the destruction of empty pesticide containers and unusable stocks.

10. Training and Incentives

In early 1987, George Popov was sent to Mali on FAO funds to do egg pod surveys, monitor locust movements, and to conduct field agent training. In late 1987, Popov again helped to train 10 to 15 field agents, funded by AELGA, on egg pod survey in addition to conducting egg pod surveys and evaluating CPS L/G control efforts. His trip report is available in both French and English to act as a guide for the CPS. Additional AELGA-funded in-country training was performed by Carl Castleton to educate farmers on pesticide application, L/G identification, safety, and other control methods. This training was deemed to be extremely effective by USAID/Mali and by the CPS. Indeed, the training was so effective that farmers dug up egg pod fields that were intended for Nosema trials. Castleton also produced a training manual for Mali.

In contrast, the AELGA-financed Dynamac trial in 1987 did not involve sufficient collaboration with the Malians to help train the host country nationals in research methods. This situation is discussed in greater detail in Section III.

There were two regional training workshops; one in Dakar to "train the trainers" to which one Malian was sent, and the other was in Niamey for aerial operations training in which two Malians participated. The Niamey workshop, in the view of the Malian CPS, was less effective than the Dakar workshop because the two Malians who attended in Niamey were not field-level individuals: the workshop was not attended by those who could have benefitted the most. USAID/Mali and the CPS both emphasized the need for training to be directed toward field-level personnel. Aerial operations training was

indicated as a present need despite the Niamey workshop, as many aerial spray applications were deemed ineffective (presumably due to calibration problems).

The UNDP began in August, 1988, a six-year long development project with a proposed budget of $7.5 million ($2.5 million will be provided by UNDP and the rest presumably by other donors). One component of the project involves training, which has been separated into three categories. One is geared to opportunities for Malian CPS agents to study abroad in M.S. programs on pesticide use. Another category is to initiate annual meetings at the CPS for the heads of all Malian phytosanitaire bases to receive continuous training. A sum of $20,000 has been allocated for this aspect of training. The third training category, to begin in March, 1989, is to teach at least 300 government-employed trainers to conduct training at the village level on L/G identification, and use of spray equipment and pesticides. For this village level training program, $150,000 has been budgeted, and an additional $330,000 has been proposed for the trainers to go to the villages to educate 200,000 farmers in at least 2,000 villages using practical demonstrations. AELGA may contribute to this effort by supplying training aids such as illustrated posters, publications, and visual demonstrations.

As for training incentives, USAID/Mali has provided per diem to farmers and agents to come to Bamako for training. AELGA could have posters on locust biology and identification, control techniques, and pesticide handling printed and distributed. Safety training seminars are discussed in the "safety" section of this Mali report, and this seems a viable option for worthwhile AELGA funding.

Should AELGA funds be allocated toward continuous activities, the life span of AELGA should be extended. The institution of continuous training would enhance anti-locust operations, and environmental and human protection from the potential adverse effects of pesticide application.

11. Environmental Concerns

The Government of Mali is quite concerned with environmental issues. In March of 1988 CILSS held a conference on environmental issues in Segou, Mali, as an attempt to nurture a regional interest in environmental protection. An OAU (the chairman of the OAU is the president of Mali) meeting will convene later this year to address ecological and toxic waste problems at the pan-African level. An OAU agenda and draft resolutions are scheduled to be completed by June, 1989, and although the OAU meeting is African is scope, scientists world-wide are invited to attend. At present, the OAU has no formal regulations on toxic waste control and is limited to "moral persuasion" alone; the proposed conference may initiate the remedy for this situation. The Malian concern for the toxic waste issue was glaringly reflected by its being remiss in permitting the Nosema trials to be conducted within the borders of Mali, even though the bait formulation was delivered. AELGA funded research--the Dynamic pesticide trials and the Nolo-Bait tests--is discussed in Section III.

Because the Dutch have begun to undertake a six-year environmental anti-locust pesticide monitoring study (Senegal/Mauritania) in which numerous ecological compartments (i.e., birds, insects, and aquatics) will be observed, it is unlikely the AELGA needs to contribute toward such long-term endeavors. AELGA could, however, provide short-term TDY to assist in the initial design and implementation of the project. The problems encountered during the Dynamac trials under AELGA sponsorship should serve as a valuable template for improving future research attempts at environmental monitoring.

D. NIGER CASE STUDY

1. Background

Relative to Mali and Chad, Niger is poorly equipped. The greatest weaknesses, according to the CPS, are logistics and coordination of operations efforts. It was evident, given the size of Niger and the presence of strategic desert locust breeding areas, that operational aspects such as survey, aerial and ground pesticide application, training, safety, and pesticide storage and disposal, and empty drum disposal are in need of improvement. The CPS formulated a biennial (1989 - 1990) plan based upon the 1988 strategy and level of donor assistance (80% of operational needs were donated), but USAID/Niger views the plan as ambitious and heavily reliant on spray, rather than IPM, tactics. In 1989, the CPS has estimated that desert locust treatments will cover approximately 900,000 ha.

USAID/Niger has indicated a desire to develop more long-term strategies with the capacity for emergency response; the mission in Niamey, in fact, has established its own L/G emergency unit through mission buy-ins. This was feasible because the USAID/Niger mission had as large OYB.

Niger cooperates with its neighbor states, in addition to more external European, Asian, and North American donors. A donor technical subcommittee, chaired by the Ministry of Foreign Affairs, meets every 15 days, and donor coordination has been characterized as being "very good." There are three "eco-political zones" that involve Nigerian cooperation with neighboring states, and each of these "cooperatives" deals with the dissemination of locust information to the other members. One such eco-political zone is the "Lake Chad Nations" which encompasses Niger, Cameroon, and Chad. Another eco-political zone exists between Niger and Nigeria, and the third zone is shared by Niger and Burkina Faso.

Niger receives assistance from various nations besides the usual donors by supplying survey teams, vehicles, and fuel. Nigeria donated a Cessna aircraft. And, Libya donated a plane and pilot for two months, but it was only used for three days to apply malathion.

In all, the AELGA project in Niger has not been notably responsive or productive. The technical assistance for pesticide disposal has been described as having been "inadequate and controversial," and $50,000 that came from the $2.1 million grant to FAO (698-0517-G-IN-8997-00) cannot be differentiated from the other funds. Of all the AELGA contributions to the L/G operations in Niger, only the greenness maps and the 20,000 liters of pesticide were unqualified successes in terms of timeliness and efficiency. The three APHIS specialists sent on AELGA funds were characterized as a partial success. The lack of clarity about the fate of the AELGA grant to FAO indicates that more control needs to be exerted over AID moneys routed through FAO. The other items that were supplied via AELGA funds will be discussed elsewhere in this document.

2. Pesticide Selection

Niger has, during the course of the ongoing L/G campaign, received donations of fenitrothion, malathion, deltamethrin, cypermethrin, tralomethrin, propoxur, DDVP, and dieldrin, among other insecticides. As of November, 1988, Niger has on stock 30,100 liters of tralomethrin ULV, 80,875 liters of fenitrothion 1000 ULV, 80,000 liters of fenitrothion 500 ULV, 5,750 liters of fenitrothion 50 percent EC, 26,900 liters of lindane 30 percent, 252,762 kg of lindane 5 percent, 2,200 kg of lindane 1 percent, 22,300 liters of malathion 50 percent, 12,000 liters of malathion 95 percent ULV, 15,000 kg of malathion 5 percent, 8,485 kg propoxur, and the dieldrin (Section 9 on disposal). If necessary, AELGA could augment malathion ULV stocks on an emergency request, especially if a pesticide bank is created to expedite the process of responding to pesticide needs quickly.

Donor coordination on pesticide selection in Niger was characterized by the CPS as being "poor" because the donors bring in their own pesticides without prior consultation with the Nigerian CPS. This has resulted in diverse and often inappropriate stocks of expensive pyrethroids, and environmentally unsound organochlorines such as lindane and dieldrin (Dieldrin is also noted for its corrosiveness to aerial spray apparatus.) The Nigerian CPS, is requesting for 1989, additional pesticide donations, but the previously described conditions are apt to continue unless donor coordination is improved. Importantly legislation within Niger, is presently under review to prohibit the entry of organochlorine insecticides into the country. The legislation, also deals with the commercialization, use, and quarantines of other insecticides. The Nigerian CPS has indicated an overall preference for malathion and fenitrothion ULV formulations, although propoxur dust and fenitrothion EC formulations are widely and effectively used by farmer brigades, which are the first line of anti-L/G defense. CPS teams use fenitrothion ULV, malathion ULV, propoxur dust, and tralomethrin. Despite the CPS's displeasure with donations of lindane and dieldrin (both of which have received relatively recent use), the CPS will utilize their organochlorine insecticides, should the need arise because alternative insecticides are unavailable.

Once again, the concept of a pesticide bank, in combination with legislation to prohibit the entry of organochlorines into the country, may serve to stabilize the uncontrolled and uncoordinated donations of insecticides for L/G operations. AELGA should concentrate

funding toward the establishment of a multilateral pesticide bank such that L/G-afflicted nations can receive relatively safe pesticides in an expedient manner.

3. Pesticide Distribution and Monitoring

The irregular conditions and relatively poor roads in Niger make timely pesticide distribution a difficult proposition. The concept of an aerial bank may have application in the emergency distribution of pesticides in Niger. Otherwise, preplanning and the prepositioning of pesticides prior to L/G onslaughts is mandatory for maximizing the efficiency of control efforts. Logistical TA, as described in the Mali section of this report, is a matter of high priority, and could be supplied through AELGA funds. The renovation of logistical methods in Niger, as in Mali, Chad, and Mauritania, would simultaneously solve the problem of monitoring pesticide distribution in-country such that stocks on hand on an area-specific basis are recorded and up-to-date.

4. Pesticide Safety

Safety clothing in Niger is not necessarily in short supply, except in the case of the brigade farmers. All CPS control teams are equipped with the full compliment of safety clothing while the farmers are given cotton coveralls and paper masks only. Aerial crews, like the CPS teams, have respirators, coverall, gloves, and boots. Although the safety clothing is available, it is not always worn, as many loaders and handlers do not recognize the hazards of pesticides unless the symptoms are acute and immediate. Canadian International Development Agency is providing 5,500 sets of protective gear for farmer brigades to be used in the 1989 campaign.

Locusts are consumed in Niger, and there have been reports of human toxification as a result. The CPS issues radio warnings against the eating and selling of locusts, but it is doubtful that such messages ever reach the more rural and nomadic peoples. Prior to insecticide applications, the chief of the village area to be treated is requested by Department CPS agents to encourage the local inhabitants to cover their water and food stores, and to remove livestock from the intended treatment zone. In 1987 the CPS announced its intention to treat pastureland in the south with fenitrothion to combat OSE, but the Ministry of Livestock refused to grant permission for fear of contaminating the domestic animals.

Nigerian hospitals have atropine and allegedly know how to diagnose and treat pesticide poisoning cases. The hospitals, however, are located only at the larger administrative levels, which makes access to them difficult, especially in the larger northern departments. This situation indicates a need to train CPS field personnel and health agents at the arrondisement or village levels in pesticide toxicity treatment. The health workshop proposed in Mali in which there will be collaboration between the Ministry of Health and the CPS should be initiated by Niger as well; AELGA could contribute to such an effort as it should in Mali.

Niger has distributed several well-illustrated cartoons on pesticide safety precautions that the AELGA project could print enmass and finance distribution. Other posters on pesticide poisoning symptoms and treatment could be devised and distributed on AELGA funds through USAID/Niger. The workshops on health, if conducted within each nation (Chad, Niger, Mali, and Mauritania) could be assisted by an AELGA-funded technical assistance individual who is a specialist on such matters, and who could conceivably help in setting up the workshops and present portions of them using practical demonstrations during a short-term TDY.

5. Survey

The capacity to conduct extensive and accurate surveys in Niger is weak. AELGA has provided greenness maps which are very useful, and help to reduce performing surveys in areas unlikely to sustain L/G. Nevertheless, Niger suffers from a lack of both experienced personnel and survey vehicles. There are only five survey teams in Niger; two in Niamey and three in Agadez. Each team is composed of one 4X4 vehicle with a driver, a scout, and a workman. This situation is further hindered by fuel shortages and rough and remote terrain. In 1988, not all of the vehicles had radios but in 1989, the CPS will have 37 radios, some of them donated through FAO (presumably with AELGA funds), and the CPS will have access to seven radio frequencies. The CPS is also requesting seven more prospection vehicles and 30 mobylettes to augment survey efforts. So far, prospection has relied on far more informal means: collecting information from nomads and ex-OCLALAV prospectors (only five or six left in Niger) who are presently employed as tour guides. Thus, most of the survey is performed by word-of-mouth and is apt to be too slow and inaccurate to be of considerable value. It is recommended that the CPS hire the ex-OCLALAV scouts for its own prospection purposes. In addition, those survey people who are presently employed need training in map reading, general survey techniques, and radio operation and reporting protocols. It has been suggested that AELGA fund a "train the trainers" workshop on survey methods which would include map reading, reporting procedures, and survey methods. Such a workshop, conducted on a regional basis or by a short term TDY who moves among the affected nations, should be very productive. The trainers may also be shown how to set up information-gathering posts at local markets so that local CPS agents can both collect information on market days and disseminate information on pesticide use and safety. A standardized survey reporting form was supplied by USAID/Niger, but it was introduced too late during the 1988 campaign to have received adequate use. The USAID/Niger mission should be encouraged to distribute the forms prior to the 1989 campaign, and, if necessary, to have the data blanks conform to those used by the FAO.

Aerial survey in Niger depends upon donated flight time. (Although the CPS desires to purchase its own helicopter, this is a prohibitively expensive proposition due to maintenance costs and the scarcity of pilots. Nor has the Nigerian military contributed significantly to aerial survey efforts.) Thus far, donated survey helicopters have not flown with spray booms or pesticide tanks. This should be corrected in future operations because without ground marking of infested areas fixed wing aircraft can only approximate the areas on maps. Survey aircraft should continue to be supplied through

donations; AELGA funds do not seem necessary for this given the history of past donations. Use of technical assistance to develop a strategy for aerial survey and logistics in common with aerial applied techniques may be appropriate.

While crop producing areas are surveyed, more survey work should be concentrated in the Air Mountains and the Temessna region. These rugged and remote areas, must be primarily surveyed from the air, thus the concern for more aerial capacity in the north to better deal with these strategic desert locust breeding grounds.

6. Aerial Application

In 1988, Niger had a total of eleven fixed wing aircraft and two helicopters. All aircraft were equipped with air-to-ground radios which operate on a special frequency. In 1989, the Nigerian CPS envisions that 500,000 ha. will be treated by air and that aerially applied pesticides will cost almost $1,818,000. Some operations in the north (i.e., Air Mountains) are planned for striking at traditional breeding areas, even though the primary focus of Nigerian anti-L/G efforts is on crop protection. The use of aircraft in Niger for survey and for application of pesticides in strategic breeding areas (which are remote and often inaccessible by terrestrial means) should be encouraged, while farmer brigades and other ground control efforts should be utilized for crop protection, provided that there is sufficient time for prepositioning and preplanning. The need for treating breeding areas is obvious not only to the CPS and USAID/Niger, but to neighboring nations as well. Survey and spray aircraft from neighboring and other L/G-afflicted nations (i.e., Algeria and Libya in particular) should be used mainly in the Air Mountains and the Temessna regions so that these other nations derive benefit from their own donations. Crop protection, if preplanned in conjunction with accurate egg pod surveys, can make maximum use of terrestrial farmer brigades and CPS teams with minimal aerial support. Turbo thrush aircraft, in particular, should be placed in the north due to their longer flight range than other fixed wing aircraft. It is recommended that the Turbo thrush aircraft have two seats such that they can be utilized for pilot training (at present Niger has only two pilots) in addition to functioning as spray craft. Although Turbo thrushes suffer mechanical problems as a result of sand intake, they have a greater flight range than the other small fixed wing aircraft, and engine maintenance and repair is easier than for the other aircraft.

At this time, aircraft calibration is not done in Niger, although tecchnical assistance was provided in March, 1989. A training course in 1989 in ULV application will, hopefully, instigate more conscientious attention to the importance of calibration. Until now, it has been estimated that fenitrothion 1000 ULV was applied at the very low rate of 0.25 liters/ha, and malathion 95 percent ULV at 0.5 liters/ha. using micronaire atomizers. Follow-up surveys to estimate the resulting locust kills have not been conducted so it is unknown whether these rates are efficacious or wasteful. It is imperative that field personnel attend the USAID-funded ULV workshop in Niamey to ensure that the information is passed to those individuals who will benefit most. If the workshop is regional in scale, other participating nations should be encouraged to send field-level personnel, instead of high level CPS officials. AELGA could help to fund such a

workshop, especially if it is within a regional context, and the technical assistance should be well-chosen and fluent in French.

The CPS has a clear decision making process for choosing between farmer brigades, CPS teams, and aerial intervention. When during survey a CPS agent finds an infestation of five or fewer L/G per square meter, farmer brigades are dispatched. If there are more than five L/G per square meter, the agent contacts the CPS adjoint, who personally must assess the situation. After the adjoint gathers first-hand information on the extent and intensity of the infestation, the life stage of the L/G, weather parameters, the proximity of crop lands and the stage of crop growth (i.e., if, for example, millet is tall, aerial operations are deemed better than ground spraying so as not to physically damage the crop), the adjoint then contacts the CPS in Niamey and a decision is made on whether or not aircraft are appropriate. Aerial treatments only involve the use of malathion, fenitrothion, and, to a lesser extent, tralomethrin.

In 1989, the Nigerian CPS wants to repair 22 airstrips at a cost of $40,000, to purchase aviation fuel at a cost of $76,000, to obtain $72,000 worth of hangar equipment, $5,400 for aircraft maintenance, and $109,000 for aircraft insurance. If aircraft are used more strategically, depends upon preplanning for maximizing the response capacity of ground crews and farmer brigades for crop protection, the aircraft can be best utilized for tactical applications in the north and lesser expenditures than those estimated by the CPS will be necessary. Because pilots must locate spray targets using map coordinates in expansive and confusing terrain, funds should be allocated toward developing ground support crews to ensure precision spraying by flagging and using air-to-ground radios. Any funding that is not used for airstrip maintenance, fuel, and equipment in the south should be applied toward this end. As in all of the Sahelian nations that the AELGA evaluation team visited, logistical considerations are a very fundamental requirement. As mentioned throughout this report, AELGA support of the technical assistance for regional, pre-campaign logistical planning would be a judicious and constructive project for AELGA to undertake.

7. Ground Application

The CPS in Niger considers its farmer brigades to be the first line of defense against L/G infestations. There are five farmers per brigade, and 10,000 brigades are reported to exist today. All use backpack sprayers (fuel or battery powered) to treat with fenitrothion 500 EC, or dust bags to treat with propoxur dust. At present, enough insecticide is available for the farmers in 1989. The CPS wishes to augment its farmer brigades by supplementing pesticide application equipment ($2,616,000 which should be supplied by other donors) and by training new farmer brigades in tandem with continued training for veteran brigades. The Canadian International Development Agency plans to continue its $10 million project to 1990. At this time, the CIDA plan will involve the training of 5,000 new brigades and to "retrain" the existing 10,000 brigades. Thus, it is unlikely that AELGA need be involved.

Niger has about six unimogs (at least three do not have ENS systems mounted on them) and six ENS systems (some are not operational). The CPS has opted to request two more large trucks from donors; but this evaluation team would discourage this purchase in lieu of receiving more light 4X4 vehicles for terrestrial spraying at the same cost. The ground equipment should be concentrated in the crop producing areas. The CPS request for $65,000 of vehicle fuel would appear reasonable in light of the apparent fuel shortages. Most ground equipment can be supplied by other donors. AELGA funds, however, may serve to provide technical assistance for logistics, as has been discussed elsewhere in this report.

8. Pesticide Storage

Much information on storage is provided in the following section, "Disposal of Unusable Stock and Empty Drums." The AELGA evaluation team made two additional observations worthy here.

i) Pesticide storage conditions were observed within the Niamey CPS compound which is surrounded by a 5' tall stone wall. Within the wall are the CPS and CIDA offices, a vehicle yard (fenced), and a large empty metal storage shed with a concrete floor, loading docks, and numerous wooden pallets. Within 50' of the storage facility and immediately adjacent to fiberglass office trailers is a relatively large collection of pesticide stock that includes malathion, fenitrothion, deltamethrin, cypermethrin, and tralomethrin. The barrels are not enclosed within a fence, all are tipped onto their sides in direct sunlight, many are leaking and badly dented, others are entirely without labels, and empty drums are mixed among them. Being particularly cognizant that this situation exists within the CPS headquarters compound itself, it may not be difficult to visualize many of the storage practices that are occurring outside of Niamey which involve more environmentally insidious chemicals such as lindane and dieldrin.

ii) In the CPS proposal for the 1989 L/G campaign, no consideration is given to pesticide storage or disposal of unusable stock and empty drums. The possible applications of AELGA funds are addressed in the following section.

9. Disposal of Unusable Stocks and Empty Drums

The first and foremost concern of USAID/Niger in the anti-locust campaign is the stocks of dieldrin that have been donated by FAO/UNDP and Libya. There is a total of approximately 21,000 liters of dieldrin in 200 liter barrels (some of which are leaking) and at least five empty dieldrin drums of which the contents may have been applied intentionally or have leaked onto the ground. The USAID/Niger mission has emphasized that there are two basic stages that must be addressed separately when

considering the strategy for the ultimate destruction of the unwanted dieldrin stocks: i) analysis and containment; and, ii) disposal.

In the view of this evaluation team, and the USAID/Niger mission, the analysis of the extent of dieldrin leakage and subsequent contamination, especially at Tchintoulouse where five dieldrin drums presumably leaked onto bare ground with a relatively high water table (ca. 4 m below the soil surface) and a school nearby, should be scientifically analyzed. The OFDA cable of 3 February 1989 (STATE 032849/01-2) adequately describes methods by which such analyses can be conducted. Soil core samplers and laboratory facilities are available within Niger, and if the institutions at which the analyses could be performed are inadequate, the samples can be shipped out of Niger to other institutions. It is of both scientific and practical interest to perform the tests as recommended in the OFDA cable prior to characterizing the immediate and potential hazards of the situation at Tchintoulouse. The analyses of spills should be conducted in tandem with the containment of the Tchintoulouse dieldrin leaks (procedures for this are also recommended within the OFDA cable), and existing stocks of dieldrin which, owing to the poor condition of some of the full barrels, may develop into a similar potentially hazardous situation. There are six areas where dieldrin is presently stored in Niger, all are accessible by road and are concentrated in north-central Niger. Aside from the five empty dieldrin barrels at Tchintoulouse, there are up to eight barrels (some full, others empty) set on unsheltered bare soil in nearby Assode. At Iferouane there is a fenced area that holds six full barrels of dieldrin on a dirt airstrip. Approximately twelve full barrels of dieldrin (three are being used as aircraft tie-downs) set in the open exist at Arlit. At Innabangarit, 39 barrels (twenty arrived prior to 1980) have been left on bare soil without any security measures, and one drum was reported to be leaking. Finally, in Agadez, there is a warehouse with a cement floor that contains 8,400 liters of dieldrin in 200 liter barrels. Other storage facilities at Tanout, Zinder, Maradi, and Niamey were described by C.J. Rogers in his report "Unwanted Pesticides and Pesticide Containers in Niger - An Assessment and Proposed Solution." The report indicated a lack of storage facility organization (for example, different insecticide stocks were mixed together), loading areas, fencing and security, protective clothing, and many of the facilities were characterized as being too small to hold all of the pesticides on stock, so much of the stock on hand is exposed to direct sunlight.

While sampling of spills and containment of contamination is being conducted, the storage facilities in Niger should be isolated with 6 - 8' high cyclone fencing topped with barbed wire coils, and, if possible, a security guard should be hired. Shelters for the barrels in the open should be constructed with adequate ventilation at all storage sites. With specific regard to the containment of dieldrin stocks, the full barrels at Arlit, Innabangarit, Iferouane, Assode, and Tchintoulouse (if any full barrels remain there) should be loaded onto trucks with sand or soil in the bottom of the beds using a drum lifter (see OFDA cable). If the cost of overpack drums (see OFDA cable) is exorbitant, then enough overpack drums should be purchased to contain those dieldrin barrels that are in danger of leaking enroute to a site where the dieldrin will be concentrated prior to disposal. Loaders and handlers during this process must be equipped with safety clothing that includes tight-weave cotton coveralls impregnated with neoprene, calf-length rubber boots (coverall pant legs are not to be tucked into the boots), rubber gloves with

mid-forearm gauntlets, respirators with charcoal filters, hats, and goggles. At the end of each loading operation, the clothing must be thoroughly washed. Between loading sites that are handled within one day, the clothing should be removed and stored in a vehicle that does not contain the dieldrin barrels. The storage facility at Agadez seems to be appropriate for concentrating the stock of unwanted dieldrin as it already contains 8,400 liters of this insecticide and has a storage building with a cement floor. Prior to transporting the dieldrin to the Agadez facility, however, the insecticides within it must be reorganized, preferably such that the different chemicals are stored in separate and well-defined groups. Any fuel within the facility should be removed to another shelter at least 100 m. distant to make room for the incoming dieldrin and to eliminate the possibility of fires and explosions in close proximity to insecticide stocks. Once this has been accomplished, and a fence has been installed around the facility, the dieldrin can be moved. The dieldrin barrels and overpack drums must be labeled if the labels have been worn off, and the transport vehicles should carry signs on the front, sides, and back to indicate that they are carrying hazardous materials. No stops should occur between the loading sites, or between the loading sites and the renovated and secured storage facility at Agadez. The stocks of dieldrin at the Agadez facility should be concentrated in one place and clearly marked as being dieldrin so that no confusion will occur when other insecticides are placed in, or removed from, the storehouse. The empty dieldrin drums should be included in this process after being sealed in overpack drums, but not mixed among the full dieldrin barrels. The overpack drums that contain the empty barrels should clearly indicate that the barrels are empty and that they originally contained dieldrin. Those dieldrin barrels that were leaking or are empty should be kept in the overpack drums and the lids made airtight to prevent fumes from escaping within the confines of the storage facility. Under no circumstances should the stocks of empty and full dieldrin barrels be removed from their site of concentration in the Agadez facility until such time as they will be destroyed.

We detail the measures necessary to consolidate the stocks of the these dangerous chemicals because it is conspicuously evident that the issue of pesticide containment and disposal has been sorely neglected. Precisely no government or donor institution wishes to take on the responsibility. Disposal is a major issue. It must be dealt with.

USAID/Niger was unaware that the Regulation 16 waiver applies only to the use and distribution of insecticides used in the L/G campaigns. The containment and destruction of nonwaivered insecticides is permissible. That AELGA management was unaware of this critical interpretation of the waiver was demonstrated by its not granting permission for the AELGA-sponsored technical assistance of March 1989 to deal with the pressing dieldrin issue. This indicates a lapse in understanding the waiver and in relevant decision making processes. In all, two technical assistants were sent to Niger under AELGA funding. Both were viewed as controversial and inadequate. The first technical assistant went to Niger in late 1988. He wrote a report titled "Unwanted Pesticides and Pesticide Containers in Niger - An Assessment and Proposed Solution." The report illustrates several weaknesses. First the author holds a patent on a certain chemical process for the alleged detoxification of organochlorine, organophosphate, and carbamate insecticides while still in their drums. This represents a possible conflict of interest. Second, the report states that the concentration of dieldrin stocks in one location is not

appropriate, feasible, or logical. But the same report recommends that all insecticides be concentrated in a central warehouse for distribution to the field as needed. Third, the report was centered primarily around the patented technique, but did not address other pesticide stock disposal methods, and completely failed to discuss the issue of drum disposal. The proposed technique has not been field tested, and some reports have indicated that the method may not be successful or safe. Such superficial treatment of a hazardous and sensitive issue can only be regarded potentially dangerous.

The second technical assistant on disposal issues was sent to Niger at the same time as the AELGA evaluation team. Two problems arose. One, the technical assistant admitted (only after arrival in Niger) that he was not qualified to deal with pesticide disposal issues. And, two, the AELGA management expressly forbade him to address the most urgent situation of the dieldrin leaks. His report is now being edited.

The USAID/Niger mission has clearly and correctly separated the components of pesticide disposal into the two categories of i) analyses and containment, and ii) disposal. Disposal, however, must also be categorized into two subcategories: a) unwanted pesticide stock destruction and b) empty drum disposal. For the immediate future, the USAID/Niger mission wishes to concentrate on analyses and containment. In the longer term (i.e., after three months have elapsed for analyses and containment procedures to be executed), the issues of unusable pesticide stock destruction and drum disposal should be addressed in Niger, and AELGA is an appropriate funding source. The first step in dealing with both issues is to provide unbiased and highly qualified technical assistant to Niger to identify all possibilities for unwanted pesticide stock destruction methods, including cement kilns and the method suggested by C.J. Rogers. In the meantime, empty drums should be punctured, crushed, and buried. The technical assistant should also be qualified to make determinations on the utility of drum renovation techniques in the Sahel, but until that time, the CPS in Niger should be encouraged to thoroughly perforate, crush, and bury empty pesticide containers. The burial site(s) should be established in uninhabited areas with a low water table, and the excavated pit should be lined with cement rendered impermeable to liquid solutions. The pit can be filled by layering the crushed drums with soil and lime to cover each drum layer. The burial area must be securely fenced, with warning signs indicating that hazardous materials exist within.

The AELGA project can play a constructive, needed, and requested role in helping to alleviate the problem of amassed quantities of undesirable pesticides. AELGA funds may be directed toward the purchase and construction of adequate fencing around storage facilities, the construction and/or modification of existing store houses, the rental of transport trucks, the purchase of overpack drums and warning/ identification labels, providing moneys needed for dieldrin spill analyses materials and methods, and providing qualified and dedicated technical assistance to ensure that these matters are addressed/executed safely and properly.

10. Training and Incentives

As in all of the other Sahelian countries that the evaluation team visited, the CPS in Niger views training as an important facet of L/G control for ongoing and future operations. The CPS in Niger, indicated that it would be helpful if military personnel were included with the training programs.

With regard to survey, training should be conducted at the farmer and even nomad levels; CPS information gathering posts at local markets could be established and, simultaneously, information on reporting of swarms and pesticide use could be disseminated from such market posts. USAID/Niger and the Nigerian CPS have both stated that training sessions on map reading, radio message transmission, and survey techniques would be desirable for CPS agents, and that the ex-OCLALAV scouts still in Niger would serve well as trainers. The CPS has a number of colorful and informative cartoon posters on safe pesticide application methods, and it would be fitting should AELGA funds be used to print and distribute such guides to CPS field personnel and village chiefs. Other posters in Niger concerning L/G identification are available and should be printed and distributed, At present, farmer brigades are trained by CPS agents; new brigades are formed and educated while veteran brigades receive continued training. Farmer education is viewed as being essential because, given the limited resources available to the CPS, farmer brigades are the first line of defense against L/G infestation for crop protection purposes. The CPS, in its proposed campaign plan for 1989 indicated that 33 CPS agents should receive retraining (at an estimated cost of $72,000) in addition to 5,000 new farmer brigades and 12,000 veteran brigades. The farmer brigade training and the trainer per diems were estimated to require $145,440. A CIDA plan with a total budget of $10 million (which will extend into 1990) is beginning a "specialist implementation" phase that will include the education of 600 trainers to teach 10,000 farmers in pesticide application methods. CIDA has also trained 5,300 mechanics to maintain vehicle and pesticide application equipment to augment the existing one mechanic per arrondisement presently on hand. It would appear, then, that other donors are already involved with farmer training programs, and that AELGA funds may be constructively applied toward the printing and distribution of posters on safe pesticide application, L/G identification, and pesticide toxicity symptoms and treatment.

Thus far, three workshops have been held in Niger; one by GTZ on pesticide application and survey techniques (considered good), one for greenness map interpretation financed by AELGA (also good), and another for aerial operations funded by AELGA (considered controversial as the Nigerians in attendance were not field level personnel). In 1988, AELGA provided three APHIS specialists for logistics and pesticide application, but this technical assistant did not concentrate on training. Neither of the techincal assistant individuals provided to USAID/Niger on pesticide stock and empty drum disposal trained Nigerians on disposal methods or issues. USAID/Niger intends to conduct two more workshops; one on "training aid development" in April of 1989, and another on pesticide application in June or July of 1989. AELGA funding should be directed toward the execution of both and appropriate personnel should be encouraged to attend. Both workshops will, if conducted with adequate planning and relevant curriculum, be quite useful. In addition to the aforementioned training that has

been done and is being planned, training in management/ logistics, pesticide disposal and storage, pilot-oriented pesticide application methods, and medical treatment of pesticide poisoning should be considered for future AELGA expenditures.

11. Environmental Concerns

Niger contains several national parks, mostly in the south where L/G campaigns are not common. The Air Mountains are considered environmentally sensitive, and there are one or two national parks situated in this region, including the Tchintoulouse valley where dieldrin leaks have been verified. In the past, dieldrin has been sprayed in the Air Mountains region. Nigerian environmental consciousness seems to be awakening, as reflected by the Nigerian government's concern over toxic waste and the pesticide regulation legislation presently undergoing review. Nevertheless, the Nigerian assertion that organochlorines will be used if L/G infestations become critical (and this presumably includes the Air region) conspicuously indicates their prioritzation of environmental issues during emergency operations. The World Wildlife Fund, in part responsible for bringing the Nigerian dieldrin situation to the limelight, appears capable of dealing with environmental concerns in Niger. Agencies and institutions that deal exclusively with environmental concerns should be encouraged to increase their activities in Niger without direct AELGA collaboration.

E. MAURITANIA CASE STUDY

1. Background

Since November, 1987, desert locusts have invaded and re-invaded the Republique Islamique de Mauritanie (RIM). In September, 1989, up to 2,750,000 ha. were infested, especially near Aioun. Locust swarms have been reported in nearly all areas of the RIM, and breeding has occurred in both the southern and northern halves of the country. Swarms originating from and passing through Mauritania have, in response to drying conditions, wind patterns, and ITCZ movement, shifted south into Senegal, north into Morocco, and east to Mali and Algeria. Thus, the RIM can be considered both a breeding area and a pivotal point for large locust migrations; the RIM is thus seen as an immediate problem for Mali, Morocco, Algeria, and Senegal. The weak RIM CPS has so far only been able to target its efforts to crop protection, much to the chagrin of its neighboring states.

In addition to desert locust assaults, the southwestern portion of the RIM is subject to serious grasshopper threats to its millet, sorghum, and vegetable production. The periodic drying of the region, which tends to cause locust movement north and south, exacerbates the grasshopper situation.

Last year, crop protection efforts were deemed very successful (900,000 ha. treated) because, according to both the RIM CPS and USAID/Mauritania, the effort was largely

a US-led operation which involved the Peace Corps, USAID, the RIM CPS, RIM military, and other donors. Although one OFDA-sponsored technical assistant report indicated that the use of Peace Corps was inappropriate, all other parties interviewed strongly lauded the use of the volunteers. This evaluation team would urge that other L/G-affected nations similarly train and mobilize Peace Corps volunteers to help deal with L/G campaigns. The RIM CPS was pleased with the result of the American-directed campaign, and the RIM CPS hopes for a repeat performance in 1989. The effort in 1988 was set up as a mobile camp with three to four fixed wing aircraft, a helicopter, and ground support which aimed solely at crop protection, starting in the southeast and moving with the swarms toward the southwest. The north and north-central portions of the RIM were not part of the control scheme, hence swarms continued to move, unabated, into Algeria and Morocco. AELGA funds provided through the USAID mission buy-in mechanism for fuel and spare parts, were unfortunately ineffectual as the materials that were given to the CPS appeared on the black market within only two weeks of arrival. USAID/Mauritania does intend to impose more control over such supplies in 1989, and, in conjunction with the CPS, plans to conduct another USAID-centered anti-L/G operation, even though the 1988 campaign was initiated late (locusts had already reached the fledgling/adult stage before control efforts were undertaken). The late start of operations was primarily due to poor preplanning and prepositioning of materials, pesticides, and personnel.

The 100,000 liters of malathion ULV supplied by OFDA in FY 1988 was characterized as having been timely.

For USAID/Mauritania, it is hard to plan for effective operations when a set budget is required in January 1988 due to the unpredictability of L/G crises. No other funds were made available until AA/OFDA visited RIM, but even this funding missed the key operational "window" of October (OFDA money and planes did not arrive until November). This year no money from OFDA or AELGA has been allocated. Other donors are expected to supply aircraft and pesticides, as they have in the past. But greater donor coordination is needed.

In the RIM, there is confusion as to the purpose and potential of AELGA support. It is strongly advised that AELGA management send cables as soon as possible to all nations that are under the purview of AELGA to explain the capabilities of AELGA. The cable should address all possible aspects of L/G operations that can be handled by AELGA funds (i.e., aircraft leasing, pesticides, training workshops, TA, storage facilities, and disposal of pesticides, to name a few).

TA teams sent via Africa Bureau and OFDA never provided trip reports to USAID/Mauritania which has further retarded RIM CPS and USAID/Mauritania efforts at judicious planning for 1989 strategies. Nor have AELGA budget reports for FY 1989 been sent to USAID/Mauritania. Being cognizant of RIM's strategic location in terms of L/G, USAID/Mauritania should be kept well-informed of all technical assistant assessments and pertinent budgetary considerations to allow them the luxury of preplanning and prepositioning of materials to more effectively deal with L/G onslaughts

in 1989. A strategy of early planning would help to circumvent the log-jams of materials that typically accrue in customs.

Due to the recent greening of vegetation in the north as indicated by greenness maps provided by AELGA, a multilateral survey team composed of USAID/Mauritania, ALgerian, Tunisian, and RIM CPS campaign experts will conduct a scouting tour of these areas in mid- to late March of 1989 to help plan RIM and donor strategies for the expected spring-summer campaign.

At present, the RIM CPS has 140 CPS agents throughout the country, and a total staff of 250 individuals. An infestation of the same magnitude observed last year is expected for 1989. The RIM Ministry of Agriculture has proposed a "three lines of defense" strategy for 1989. The first line is to be located latitudinally parallel to the Senegal border where aircraft, pesticide stocks, and vehicles are expected to be prepositioned primarily for crop protection purposes. The second line of defense roughly parallels the first line but is located slightly farther north. A third line of defense has been proposed in the northern reaches of Mauritania and is doubtless for strategic purposes. The USAID/Mauritania chronological plan for 1989 was delineated as follows: January through May, assist CPS to prepare for the upcoming campaign with survey, training, pesticide prepositioning, and vehicle preparation. In June, survey team operations will commence in southern Mauritania, supplemented by helicopter forays. Ground operations are expected to begin in July directed against larval bands, and by August these operations will be augmented by aerial spray support. Maturing swarms will be followed by operations teams toward the west, and all available resources will be employed to protect maturing crops from October to December. No specific references were made to strategic control efforts in the north of the RIM.

This evaluation team, having noted the reluctance of nations to take responsibility for implementing control in strategic breeding areas within their respective borders, and the unlikely or haphazard multinational approach to dealing with critical sources of locust inoculum that are responsible for generating populations that will force repetitive and intensified crop protection programs in future years, calls attention to another possible tactic. The RIM, like Niger and Mali, serves as a useful example. Similar to the other Sahelian nations visited, the RIM CPS seeks to strengthen the capacity of its farmer brigades to serve as the primary means of crop protection against early instar L/G nymphs. The early prepositioning of terrestrial operations materials in the south to be utilized by the proposed joint USAID and RIM CPS using ground equipment and limited aircraft stationed with a mobile base camp would likely be effective for timely crop protection.

Due to the remote and inaccessible terrain of the northern breeding areas of the RIM, and the presence of land mines scattered through the northern desert, ground survey and control are not recommended. Helicopter survey and fixed wing aircraft should be prepositioned within reach of the known breeding areas, and operations should commence as hopper bands are detected. The annually donated Algerian teams should be combined with RIM personnel to conduct these strategic operations with donated planes and pilots. The 1988 spray operations were twice halted in the south because the

base camps ran out of pesticides, tactical prepositioning of pesticides and fuel should be a significant consideration for northern operations.

While Algerian technicians are usually welcomed into the RIM, Malian and Senegalese cross-border intervention is discouraged by the RIM for fear that such external assistance will be perceived by other donors as a rationale for reducing aid. Whether or not this may actually be the case, the RIM should be encouraged to permit such intervention in the south to augment ongoing RIM operations, and to help contain the spread of L/G infestations into Mali and/or Senegal. Coordination through an inter-state commission, such as the OMVS, could be helpful in this regard.

2. Pesticide Selection

The RIM CPS has 56,000 liters of dieldrin stored at Aioun-Atrouss and some French-donated lindane. The CPS has indicated that, if necessary, these organochlorine insecticides will be used in the locust campaign. The USSR has already sent methyl parathion, and the CPS wishes to keep it to use against locusts if alternative insecticides are in short supply. For 1989, the FAO has allocated $850,000 for the RIMs pesticide needs, but the chemicals have not yet been selected.

Malathion has been shown to kill adult locusts relatively slowly which is why the RIM prefers to use more rapid-action insecticides such as DDVP. In 1988, however, only malathion and fenitrothion were used. In 1989 the RIM CPS would like to use deltamethrin to treat infestations that occur in or near cities. (Last year Nouakchott itself was invaded.) USAID/Mauritania has indicated that the pesticides used must be stipulated in Waiver 16.

As of March 6, 1989, there was 276,480 liters of liquid and 513.51 tons of powder formulation pesticides for anti-L/G use in the RIM. This stock is composed of 141,865 liters of fenitrothion 50 EC, 3,000 liters of fenitrothion 96 percent ULV, 3,900 liters of fenitrothion plus fenthion, 600 liters of fenitrothion 1000, 25,200 liters of malathion 25, 15,590 liters of malathion 95 percent ULV, 14,725 liters of lindane, 20,000 liters of diazinon, 21,600 liters of chlorpyrifos, 30,000 liters of methyl parathion, and 56,000 liters of dieldrin. The powder formulation stocks were composed of 71.35 tons of fenitrothion 1.8, 26.6 tons of fenitrothion 3 percent, 276.85 tons of chlorpyrifos, 95.26 tons of propoxur, and 43.45 tons of pyrdaphenthion. Pesticide donations in 1988 primarily came from FAO, Algeria, China, EEC, France, Japan, Morocco, Saudi Arabia, Spain, Tunisia, USAID, USSR, and the World Lutheran Fund.

3. Pesticide Distribution and Monitoring

Early prepositioning of pesticides is essential for the 1989 campaign, as demonstrated by the 1988 campaign in which operations were twice halted when pesticides at the operational bases became unavailable. At a donor committee meeting attended by the AELGA evaluation team, it was decided that pesticides be selected and prepositioned

along the lines of defense before the end of April. As has been mentioned in the other country sections of this report, a viable pesticide bank seems the most optimal mode for having pesticides available on standby for rapid transfer to afflicted nations. The implementation of a similar aircraft bank with transport planes as well as survey and spray craft would be highly desirable for expediting such logistical considerations, especially for emergency response.

The 20,000 liters of malathion received in 1988 via USDA reportedly demonstrated that USDA is not better equipped to handle emergency pesticide shipments than AID/AELGA. The 100,000 liters of malathion ULV supplied through AELGA in 1988, however, was characterized as timely. In light of less timely AELGA shipments to other countries, the pesticide bank/aircraft bank concept appears to be a better bet. The RIM CPS and USAID/Mauritania suggested that pesticide stocks be ferried to prepositioning sites via aircraft (due to rough terrain which may result in damaged barrels or in slow shipment time). **It is tangentially recommended that the pesticide drums for aerial transfer be available in smaller, more manageable containers than the usual 200 liter drums.**

4. Pesticide Safety

The RIM CPS lacks sufficient protective clothing. Traditionally the RIM gets donations of safety clothing from Italy, France, and Japan, but they are wear out quickly, and the clothing is often not used at all because of the heat. Most loaders and handlers wear only short pants and sandals. There is a very poor understanding of the possible chronic effects of pesticides on humans in the RIM. So far no cases of human pesticide poisoning have been reported.

Although it is not commonly admitted, locusts are consumed. This situation should be regarded as a potential human health risk during anti-L/G campaigns.

As has been recommended for all the nations that the AELGA evaluation team visited, safety training for CPS personnel should be a consideration for future allocation of AELGA money, as well as the printing and distribution of illustrated pesticide safety posters. The level of the RIM's health services is not high, especially for pesticide poisoning diagnoses and treatment procedures. Although atropine has been made available to the RIM CPS, the lack of adequate training in its use is well-illustrated by reports of CPS personnel having used atropine as a prophylactic instead of as an antidote. Thus, the RIM Ministry of Health should be part of any pesticide safety and toxicity treatment workshop along with the RIM CPS. The health and safety workshop proposed for Mali by the CPS, USAID/Mali, and the AELGA evaluation team can serve as a worthy model.

5. Survey

Aside from the usual problems associated with survey in remote and inaccessible terrain, Mauritania has the dubious distinction of another difficulty: the presence of explosive land mines scattered throughout the northern reaches of the country. This is a very real threat to surveyors venture off the beaten tracks. For this reason, a reliance on aerial survey operations to monitor the northern breeding areas is mandatory. Nevertheless, in mid - late March, 1989, a joint USAID/Mauritania, Algerian, Tunisian, and RIM CPS prospection team will scout the northern region. While a risky endeavor (assuming ground vehicles will be used), this sort of multilateral responsibility, and especially the direct involvement of neighboring nations with a pertinent concern for locust breeding areas in the RIM, is laudable and appropriate. It would be hoped that such responsible action be duplicated in the other Sahelian nations that harbor traditional locust reproductive areas. AELGA funds, if applied to help support the survey helicopter and the USAID/Mauritania team member would be a constructive contribution, especially when combined with information provided by the AELGA-funded greenness maps. USAID/Mauritania, however, indicated that, while the greenness maps are potentially very useful, they do not arrive quickly enough for the survey and control teams to react in a timely manner to the very dynamic vegetative conditions. USAID/Mauritania suggested that, in addition to sending the greenness maps, the greenness maps should be transferred to 8 X 11" grid maps for immediate fax. A key training need for RIM survey is in map interpretation and survey reporting. USGS is implementing both of these requests.

Terrestrial survey is conducted from agricultural inspection stations in each of the regional capitals. There is one team per station, and each team is comprised of two people in one vehicle. Not all of the vehicles are equipped with radios, or with spray equipment. These ground prospection teams stay within their regional area and they determine where they will survey based upon rainfall data, greenness information, and reports given by local people. Although the RIM Ministry of Agriculture expressed the opinion that OCLALAV should perform surveys and resume an information coordination role, it is unlikely that OCLALAV, given its financial and staffing problems, will be able to function adequately in these capacities in the near future. It would be wiser to strengthen the CPS of RIM, and those of other OCLALAV member states, so that they can each reach a level of prospection proficiency. Even were OCLALAV to be revitalized at this point, it is doubtful that the organization would still function at the outset of the next major locust resurgence ten to twenty years from now. As for the RIM itself, ground survey teams should be concentrated along the southern lines of defense for crop protection purposes. Aerial survey should be emphasized in the northern areas of the RIM.

AELGA contributions to the RIM survey effort should be mainly applied toward aerial survey efforts in the north and on the possibility of providing training for prospectors on map reading and reporting methods. Thus far, for FY 1989, only France has pledged the donation of a survey helicopter. Doubtless at least one or two other survey craft will be required, which should be a point of interest for AELGA management.

6. Aerial Application

RIM's 1989 L/G strategy campaign has been already described in the background section.

In 1988 and early 1989, OFDA sent two technical assistance teams, each with an aerial operations specialist. Neither team provided trip reports to USAID/Mauritania, and one team recommended the use of DC-3 spray craft. Should preplanning and prepositioning of pesticides, equipment, and personnel occur this year, the use of such large aircraft must be discouraged for environmental and economic reasons. Judicious use of farmer brigades to protect the southern crops and strategic, precision aerial applications in the dangerous and remote north preclude the use of such dramatic large aircraft measures.

In 1988, the RIM had two Canadian Agricare fixed wing aircraft, four OFDA Turbo thrushes, two CAE fixed wing aircraft, one Bell 206 helicopter, and three Alouette helicopters, all equipped for spraying. Aerial operations were primarily conducted in the south, while northern locust populations were left relatively unscathed to enter Western Sahara, Morocco, and Algeria. Although cold temperatures and human intervention in Morocco and Algeria apparently curtailed the fall 1988 locust migrations, the early control of breeding populations in the north of the RIM should be encouraged to eliminate this often expensive and time-consuming method for dealing with moving locust swarms in North Africa. Both Algeria and Morocco should be encouraged to consider the benefits of donating aircraft to the RIM for strategic intervention in northern Mauritania as a preventative tactic.

The FAO has pledged a Cessna airplane to be placed at Aioun, and CIDA still has two fixed-wing aircraft in Mauritania. At least three Turbo thrushes were based at the Nouakchott airport. Other aircraft donors in the past include OCLALAV and France. Should AELGA, OFDA, or another US agency deem it necessary to supply the RIM with spray craft, the planes and helicopters should be donated with the stipulation that they be used extensively for strategic control and survey in the northern areas of the RIM.

7. Ground Application

Until March 6, 1989, a total of 335,560 ha. were treated by ground in Mauritania, which was about one third of the total 955,500 ha. sprayed. For ground operations, the RIM has 12 light Nisson vehicles, 7 light Mitsubishi vehicles, 7 landrovers, 4 light Toyota vehicles, 2 other light vehicles, tow trucks, and 6 unimogs. Fourteen of these vehicles are equipped with motorized dusters, three with ENS, and one with a conventional sprayer. Clearly, for ground operations to be conducted more effectively in the south (in order to release aircraft for strategic control in the north), additional ENS systems must be procured. The RIM Ministry of Agriculture, during a donor committee meeting in early March of 1989, indicated that further vehicle donations should be coordinated so that some degree of standardization can be attained to alleviate logistical problems with

spare parts. Any AELGA contributions toward ground operations should be made bearing this caveat in mind.

The RIM presently has 5,000 - 10,000 farmers who use sacks to treat L/G infestations with propoxur and fenitrothion dust formulations. The farmer brigades operate mainly in the southern crop-producing areas and near the oases of central Mauritania. Although the RIM will use military personnel equipped with backpack sprayers and EC formulation insecticides, there is a clear need for the formation of additional farmer brigades. Both the farmer brigades and CPS teams should be concentrated in the south for crop protection purposes to allow aircraft to survey and treat the strategic breeding grounds to the north. AELGA may contribute toward this effort by helping to provide training material for the education of more farmer brigades. Such aid should be supplied as soon as possible to facilitate the coordination of anti-L/G strategies for 1989.

8. Pesticide Storage

In the RIM, pesticide storage facilities are located in each of the regional agricultural inspection stations and all were reported by USAID/Mauritania to be in poor condition, lacking shelter, fencing, and safe handling procedures. The AELGA evaluation team visited the storage compound next to the CPS buildings in Nouakchott. Barrels of dieldrin, methyl parathion, fenitrothion, and malathion (lindane stocks are located elsewhere) were observed lying on their sides on bare earth exposed to direct sunlight. Many barrels were entirely without labels, but different insecticides were apparently placed in separate locations within the area. Evidence of leaks and spills were widespread. Lime is available in the RIM but is not commonly used to neutralize organophosphate and carbamate spills. The storage compound is surrounded by a five foot tall brick wall, and a large portion of the wall abutting the road has crumbled, allowing unrestricted access to the barrels. The compound is located immediately adjacent to a large Nouakchott ghetto. Empty drums were piled near the ruined part of the wall. The team found that empty drums are widely used for other purposes in Mauritania; they can readily be found in ghetto yards and in the market place. Thus, the deteriorating storage compound in Nouakchott is an open invitation to the pilferage of the empty barrels. One FAO/ECLO environmentalist reported that Mauritanian children have been observed entering the storage site, puncturing full barrels to allow the contents to leak out in order to steal the resulting empty containers.

This potentially dangerous situation should be rectified as soon as possible by modifying the storage facility, especially in view of the fact that a relatively large quantity of Soviet-donated methyl parathion and dieldrin are present within the Nouakchott compound. Qualified technical assistance is necessary for developing appropriate storage practices in the RIM, and this should be carefully considered by AELGA management.

9. Disposal of Unusable Stocks and Empty Drums

In Mauritania, the problem of disposal of empty pesticide drums is closely linked with the adequacy of storage facilities given the high demand for and widespread use of pesticide barrels for other purposes. Empty lindane barrels were even being sold to nomads by the chief agricultural inspector until he was apprehended and forced to stop this activity. All empty barrels are presumed to be sold for other purposes in the RIM, except for Canadian and American donated drums which are systematically punctured, crushed, and buried below 12' of soil by the donors themselves. Due to the shortage of water in the RIM, the containers are not washed prior to disposal. The CPS and Ministry of Agriculture have no plan for addressing disposal issues. At this time the stocks of organochlorine insecticides and methyl parathion will be saved and possibly utilized by the RIM CPS if necessary.

TA is essential, as in all of the other nations visited by the AELGA evaluation team (Chad, Mali, and Niger) to address the needs for developing disposal methods for both empty barrels and unusable pesticide stocks. AELGA funds should be directed toward ameliorating the pesticide and drum storage conditions in all of the nations that fall under the purview of AELGA.

10. Training and Incentives

This topic was not examined in Mauritania.

11. Environmental Concerns

In Mauritania, the environment is not held to be a high priority. Empty pesticide barrels are commonly sold and used in the Nouakchott market, and barrels that look suspiciously like insecticide drums are scattered throughout the Nouakchott ghetto.

A Dutch environmental monitoring research project is presently underway, and some of the test sites may fall within the borders of the RIM. This study, however, may not involve personnel from Mauritania. Of all the nations that the AELGA evaluation team visited, the RIM seems to have the least concern for environmental issues. Thus, it is incumbent on AELGA to begin to address environmental issues directly.

F. CAPE VERDE CASE STUDY

1. Background

Cape Verde exhibits three special characteristics. First, the country, which lies in the Atlantic Ocean 300 kilometers east of Senegal, is at the tail end of the locust problem. Locusts may be blown over to Cape Verde, but they do not usually breed there. Second, the country is a chain of islands, some of which are inhabited and some of

which are not. More importantly for locust control, some islands are flat while others are quite mountainous. These conditions not only make the logistics of aerial control operations difficult, they also mean that fixed-wing aircraft are inappropriate and helicopter runs can be dangerous. Third, precisely because Cape Verde is a small island nation, the government is very concerned over the use of pesticides and their impacts on the environment. Indeed, Cape Verdian policy for pesticide certification and application regulations are among the strictest on the continent.

2. Pesticide Selection

The Government of Cape Verde has vested the certification of pesticides with the CPS. The head of the CPS takes a conservative position on the use of pesticides, and is quite clear in his preference for ground operations with baits and biological controls. In fact, he relies on the US EPA publications to determine which pesticides are to be allowed into the country. Stocks of uncertified pesticides that were donated during the locust emergency of last year were impounded at the port, where they remain today.

The Cape Verdian CPS is very small: a headquarters staff of four professionals oversees a field staff of a single technician in each of the 13 administrative districts of the country. Pesticide certification is thus an onerous task for this service, for pesticides are a very complex technical area. The problem is more severe because the GOCV would like to use the same formulation for ground and aerial operations in order to obviate some of the logistics problems of handling different stocks for different operations. It is therefore recommended that the head of the Cape Verdian CPS be provided training in pesticide selection and application at, for example, a USDA short course.

3. Pesticide Distribution and Monitoring

The Government of Cape Verde stores its pesticide stocks in a central warehouse just outside of the capital city. These stocks are moved only when necessary to areas where control operations are planned. The reasons for this policy are simple: few storage depots exist on the outer islands, and monitoring their condition would be much more difficult.

A recent review of the adequacy of the central warehouse documents a number of problems that are common elsewhere in the Sahel. The central warehouse is simply too small to store the stocks available according to recommended procedures. It has therefore been suggested that USAID, under the AELGA project, undertake the construction of a new and more adequate warehouse; this team supports that recommendation.

4. Pesticide Safety

The GOCV CPS has striven to train its workers in the proper handling and use of pesticides. Nonetheless, the CPS depends heavily on farmer brigades for ground operations. These workers sometimes do not appear to understand the use and dangers of pesticides--they will, for example, run after swarms, spraying until the insects drop, which is unnecessary because malathion does not necessarily kill on contact.

The GOCV strongly supports the notion of training in pesticide use for farmer brigades, and this team accepts that recommendation.

5. Survey

Cape Verde truly is in a special situation because locusts are entirely a foreign problem blown in by ill winds and not indigenous to the islands. Moreover, greenness maps are not usable here because the islands are almost always covered by clouds. As a result, locust monitoring in Cape Verde depends entirely upon reports from the continent, particularly Mauritania and Senegal. The continued existence of a regional monitoring organization is thus of paramount importance to the GOVC.

Once locusts arrive on the island, the GOVC undertakes aerial and ground operations with donor support. Subsequent surveying is done entirely by ground crews.

6. Aerial Applications

Aerial applications are particularly difficult in Cape Verde. In last year's campaign, it was necessary to call in a French test pilot to work out the techniques for helicopter spraying in the mountains and valleys of the islands. Although this pilot demonstrated that aerial applications were possible if one flew in barrel rolls and other risky techniques, the experience etched the importance of ground operations into the minds of government authorities.

7. Ground Application

The GOCV prefers ground applications by farmer brigades under the supervision of the resident CPS agent. In fact, Cape Verde, alone among the Sahelian countries, desires a pesticide formulation that meets the specifications for both ground and aerial applications at the same time. The search for such a formulation is spurred largely by logistic concerns. But the request reflects the emphasis put on ground operations in this country. It is for this reason that the request for additional backpack sprayers is so important, and this evaluation concurs in that request also.

8. Pesticide Storage

All pesticide stocks in Cape Verde are held in a central warehouse outside Praia. This warehouse has insufficient space and facilities for the stocks held there. USAID/Cape Verde has expressed the intention of helping the CPS upgrade this facility. This evaluation team strongly recommends that AELGA contribute to this worthwhile endeavor.

9. Disposal of Unusable Stocks and Empty Drums

The disposal of unusable stocks and empty drums is a serious problem in Cape Verde, as elsewhere. One shipment of uncertified pesticide was impounded at the port upon arrival; that stock remains at the dock because there are no disposal facilities.

GOCV recently received technical assistance under the AELGA project on possible measures for the disposal of empty drums. The concerns with the recommended measures--namely, that the cleansing procedures create more and different hazardous waste than originally in the containers--are detailed in the case report for Niger (above). This remains a major area of concern throughout the region, as this team has underscored several times.

10. Training and Incentives

Agents in the Cape Verdian CPS participated in the AELGA training program in 1987, and will participate in future training programs, as long as the logistic arrangements are made under the project.

These courses are an incentive for the Cape Verdian staff, who are knowledgeable and dedicated in the discharge of their responsibilities. It is for this reason that the team recommends that the project underwrite the cost of a short course in pesticide selection for the head of the CPS and of an in-country course on the health and environmental effects of continued pesticide use for the field agents.

11. Environmental Concerns

The GOCV is in the forefront of the Sahelian nations on environmental concerns. Government officials are acutely aware of the possibilities of irremedial consequences of prolonged pesticide use in a fragile island economy dependant upon fisheries and agriculture. And they have enacted national legislation and administrative regulations to control the certification and use of pesticides. The AELGA project could compile and disseminate this information to the other member states, perhaps through a small grant to a regional organization charged with coordination. Collaboration with OCLALAV or CILSS/INSA would be appropriate in this regard.

Further, the GOCV strongly supports research into baits and biological controls, and has agreed to conduct several such studies in these areas under the AELGA project. For this reason, the project should honor the request of the GOCV that several agents--rather than a single agent--be tested.

III. ENVIRONMENTAL CONCERNS, PRESENT PROJECT AND FUTURE RESEARCH

A. ENVIRONMENTAL CONCERNS

(SOW Section VI E)

1. What is the degree of collaboration between project management and the U.S. environmental community?

Collaboration between project management and the U.S. environmental community began promisingly enough but tapered off sharply, largely because of a lack of mutual interests.

At the beginning of the project, the USAID environmental advisor convened various environmental groups for consultations about the activities of the AELGA project. These groups decided to nominate informally one of their number, the Audubon Society, to act as the group's representative. Subsequently, even this representative group has had only limited contact with the AELGA project.

The Audubon Society did become more active when they learned that one donor (not the US) might be contemplating the use of a long-lasting pesticide, dieldrin, in locust control operations. This question was taken up at a meeting at the FAO in Rome, where a member of the Society was invited to participate. Apart from this episode, however, the environmental community has not been actively engaged in the AELGA project.

2. What project activities were involved with environmental concerns?

USAID-financed locust control activities have taken a conservative position in the type of pesticide used. Specifically, USAID has to date supplied only malathion, a short-lived pesticide that is effective against locust. Carbaryl, the other pesticide that has been pre-purchased and stocked in a pesticide bank, has yet to be used. Present plans are to take delivery of this pesticide as dust rather than liquid so that it can be reformulated into a bait for efficacy testing. This change in thinking and approach well represents the sensitivity of project management to environmental concerns.

At the same time, it must be noted that until very recently the urgency of the locust infestations has precluded most environmental considerations. The health and safety of pesticide handlers, the problems of storage and disposal of pesticide stocks, and the cumulative effects of spraying have received little attention until present. It is precisely for this reason that the evaluation team has strongly recommended short field-oriented assistance and training courses (Recommendation Set 2 and Section 2, above).

3. Is the Programmatic Environmental Assessment (PEA) serving its purpose?

The purpose of the PEA is to address US environmental legislative requirements. These mandate that:

a) AID development projects take into account, together with the host country, certain possible environmental consequences before a project is implemented (22CRF Part 216, AID Environmental Procedures);

b) a project take into account its relationship to the environment and develop mitigative measures to avoid or minimize environmental degradation (Foreign Assistance Act, Section 117, Environment and Natural Resources);

c) a project address the protection of wildlife and their habitats, national parks, and other reserves and protected areas (Foreign Assistance Act, Section 119, Biological Diversity); and,

d) a project address the need to help countries build institutional and scientific capacity regarding critical environmental and resource problems; establish resource management programs; ensure environmental and long-term sustainability of projects; and promote environmentally sound development (Policy Determination PD-6).

The PEA states that it "satisfies" these demands by addressing them in the document and by presenting a list of options and recommended actions. The PEA cannot truly serve its purpose, however, until project activities implement the intent of the environmental legislation. In this view, the PEA is currently achieving its purpose only in part, that is, to the extent that the recommended actions are being implemented. For example, with regard to the first requirement--taking into account certain possible environmental consequences before the project is implemented--the project did, early on, take into consideration important environmental issues, e.g., the restriction of environmentally harmful pesticides such as dieldrin. But the project did not deal with other potential problems such as the inevitable problem of pesticide and container storage and disposal or the concerns over pesticide handlers' safety. These are also important concerns, as this team has repeatedly emphasized, and **project management must see that the PEA recommendations are implemented.**

Several actions are necessary to implement this recommendation. First, the final draft of the PEA must be agreed upon and formalized as soon as possible. The PEA has not yet been signed into being, in part because of differences in the recommendations at the end of the executive summary and those in the main body of the text. The document is now being revised for consistency. This work must be completed and the PEA accepted before May 1989, which is the date when the waiver to the Regulation 16 expires. Second, the programmatic recommendations must be budgeted for, and implemented, if the PEA is to accomplish its aims as defined in the environmental legislation. At present, there are 19 recommendations in the draft PEA that involve budget support. Of these, only four have been or will be addressed under the current

budget guidelines for FY89. Budgeting for the remaining recommendations will require close attention by the AELGA project manager.

4. Did the project contribute to the lessening of negative impact of control programs on the environment?

As has been mentioned, the project has taken little action to mitigate the impact of locust control programs on the environment. The pesticide used represents a fairly conservative choice, which certainly lessened the negative impact of the control programs on the environment. And there was some training in pesticide applications early on in the project and again this year. The training now proposed covers only those topics that were envisioned at the outset. However, other concerns has now come to the fore, topics like human safety and container disposal. The USAID missions are acutely aware of these issues, and have begun to organize their own responses. For example, USAID/Mali recently devised an in-country conference on the human health concerns of pesticide use. Similarly, USAID/Niger has brought in two technical assistants under AELGA to address the issues of container disposal (Section II D), and will participate in a health workshop later this year. AELGA should support and coordinate these initiatives in order to heighten environmental awareness throughout the region.

Again, the urgency of locust control when the project was first authorized did not allow a fully considered program to be developed. Nor could all of the issues be anticipated at that time. But locust control campaigns have given rise to increasing concern in host governments and in USAID missions about the health and safety considerations of pesticide use, among other matters. It is, therefore, incumbent upon the project to devise a set of pertinent training courses and conferences, as has been recommended. For detail on these concerns see Sections II B through F, where the issues of disposal, of human and animal safety, of pesticide storage, and of environmental concerns are discussed.

5. What additional environmental issues should be addressed?

The draft PEA (specifically, recommendations 1-13) details the environmental issues that remain to be addressed under AELGA. Two of these issues stand out as critical: pesticide and container disposal, and public health.

Pesticide disposal and container issues have yet to be addressed adequately, as the country reports well document. Over the past decade in Africa, the US has been a leader in providing advice on the proper use of pesticides. Our most notable success has been in helping convince African governments not to use dieldrin, BHC, and other persistent chemicals. It is essential to follow through with this philosophical commitment by ensuring that the technical and physical resources exist to destroy, in an environmentally sound manner, old stocks of pesticides, and to remove pesticide containers, many of which we imported, from access to the open market. (See the section on pesticide disposal in the case studies for further information.)

Recommendation 1 of the PEA for an inventory of equipment and chemicals is recognized by USAID missions as an important activity. The missions they may not have the resources to give this matter the priority it deserves. The $75,000 currently earmarked for pesticide disposal in FY 89 might be used to help finance an international conference on the subject. The purpose would be to define the problems in each country, to determine feasible alternatives to resolve these problems, and to devise a proposal for action. It should also be noted that the amount budgeted for this important matter is small relative to the amounts budgeted for other research topics, and will likely need to be increased.

Public health concerns are another major topic. Here, too, AELGA has begun to take action, with the $50,000 earmark for a health conference in FY 89. This beginning accords with recommendations 10 and 11 of the draft PEA. The first recommendation deals with the training needs of health workers and pesticide handlers, the second with the informational requirements of the general public. Specifically, recommendation 10 stipulates that "training courses need to be designed and developed for health personnel in all areas where pesticides are used frequently. The courses should familiarize health workers with the symptomatology of pesticide poisoning and provide information on appropriate measures for first aid, specific treatment, prevention and referral to a hospital center." And, recommendation 11 underscores that "each health center and dispensary located in an area where pesticide poisonings are expected to occur should be supplied with a large wall pamphlet in which the diagnosis and treatment of specific poisonings are depicted." Both recommendations are strongly supported by this evaluation team, and are included as specific items in Recommendation Set 2 of the Executive Summary.

6. What portion of future project funding should be targeted toward environmental concerns?

It is difficult to recommend absolute or relative amounts that should be targeted toward environmental concerns when the AELGA budget can increase (or decrease) in the face (or with the disappearance) of a locust emergency. At present, 56 percent of the total AELGA funds are budgeted for research in environmental issues. The amounts allocated are: biocontrol research, $600,000 (28%); pesticide disposal, $75,000 (3%); USDA/OICD Training, $420,000 (20%); Mali health conference, $50,000 (2%); and the Niger pesticide awareness conference, $50,000. This amounts to $2,150,00 for FY89/90.

This investment in environmental concerns is significant. However, the funds must be used well if they are to be effective. Thus, the present funding level appears adequate, although some of these funds might be redirected to other activities, for not all environmental concerns identified under the draft PEA will have been addressed. In particular, issues such as pesticide disposal and safe pesticide storage conditions are growing concerns, and AELGA needs to focus much more attention upon them. It would, therefore, be useful to reserve at least 15 to 20 percent of the total AELGA

funding for these issues, even if that means reducing the level of research activities that are undertaken.

7. Did project activities influence environmental policy decisions in US, FAO/Rome, any other donors or in host countries?

When at the outset the project enjoyed strong technical assistance under the USDA/OICD RSSA, various of the positions propounded by the project were adopted by the FAO and other donors. Subsequently, the major influence of project activities has been the prohibition on the use of dieldrin in locust control operations. Neither donors nor host countries wish to use this substance, which would require USAID missions to desist from all participation in locust control if dieldrin and American-donated equipment are commingled.

There is in West Africa a growing awareness of environmental matters and an attempt to define environmental policy. This awareness is strongest in Cape Verde, which bans all pesticides that are prohibited in the United States. GOCV has in fact impounded stocks of prohibited chemicals even though they were donated. The Government of Mali has also recently become very sensitive to the issues of pesticide use. It is likely that other governments will begin to express similar attitudes for a variety of reasons. In this situation, AELGA could facilitate the development of a regional consensus on pesticide regulation and use. Specifically, a regional conference on pesticide uses and impacts could have a very beneficial effect, not only for locust control, but for all ground and aerial spraying operations, be they agricultural operations, livestock programs, or public health campaigns.

8. Is training having a significant impact on awareness and consideration of environmental issues?

The few training sessions held to date have considered the health and environmental consequences of pesticide use. These concerns have not, however, been the main topic of the training sessions. Nonetheless, training on the proper use of pesticides and on equipment calibration does indirectly have a positive impact on the environment.

The environmental issues nonetheless remain important. There are far too many anecdotes about terrestrial teams spraying until the locust physically drop (or, perhaps more precisely, drown), which occurs because malathion is a slower acting pesticide than those that kill immediately on contact. There are other stories about pesticide handlers who are so covered with the chemicals that even after a shower, the flies that land on them drop to the ground dead. These episodes, which were recounted by eye witnesses, indicate a lack of appreciation of the seriousness of pesticides and their use and dangers. Unless and until these matters are dealt with in a concerted manner, training cannot have a significant impact on the awareness of either pesticide handlers or the general public. It is, of course, for this reason that the evaluation team has repeatedly and so strongly recommended the development of additional training courses.

9. **Do project training programs provide comprehensive audio-visual materials, books, and other training materials to extend the impact and provide mid-term continuity to training?**

AELGA training programs have generally been characterized as adequate, despite a lack of audio-visual materials, books and other training materials.

A major weakness of the workshops has been the selection of the audience--upper echelon personnel instead of field personnel. This selection is almost unavoidable when only one or two participants are invited from each CPS. For this reason, it is strongly recommended that regional conferences be held for upper echelon personnel but that national conferences be held for field-level personnel. Only in this way can enough responsible staff be invited to have a meaningful and lasting impact in the operation of the national campaign.

Also, there was no training in PY 2 because of the exigencies of locust control operations. Additional courses are being planned for this year, but the topics chosen are those that seemed most relevant a year or two ago. These topics are still important. But, as should be clear from the discussion of environmental awareness, new topics have also come to the fore, and these must also be included in the repertoire of training activities. The sections on training in the case studies discuss these matters in great detail.

10. **Is adequate consideration being given to environmental concerns in actual practice? For instance in: human health, pesticide storage transportation/mixing/loading pesticides, application, efficacy trials, clean-up of spills; pesticide container disposal, non-target flora and fauna; critical habitats including bodies of water; meteorological conditions; and local populations along with their livestock.**

This simple answer to this question is: no. Of course, the situation is far more complex than that, as the individual country reports (Sections II B-F) clearly document.

Most countries have some program for alerting the general population to an impending spray operation. The effectiveness of these alerts, however, have not been studied. And, the anecdotal information that is available--five chickens dead after aerial spraying--is inadequate for a reasonable assessment. One possible action is to undertake locust mortality studies not only within 24 hours of the operation, but to look for other insects and to carry out similar studies with a longer timeframe for birds and fish. These studies could provide important information on non-target flora and fauna, on the impacts on critical habitats, and on local populations and their livestock.

Pesticide storage and handling are almost universally inadequate. This is particularly disturbing because pesticide handlers are at more risk to toxification than the general

public. The remedy here, as has already been recommended, is training courses for field-level personnel that are focussed on precisely these topics.

The overall problem is that because pesticides are not much used in West Africa, there is little familiarity with their uses and dangers. This situation is changing rapidly, as governments must consider the consequences of their actions on their populations and the environment. AELGA is well situated to facilitate a regional conference on this topic, and thus to help foster a consensus of the issues. The project can support short-term training in pesticide selection for the responsible authorities in the national crop protection services. And, the project can take a lead in general education, through the recommended publication and distribution of posters and other materials.

B. RESEARCH DIRECTIONS

(The following questions are from SOW section VIII.)

1. Consider potential for IPM program elements: evaluate current active ingredient options (alternatives), decisions and impacts.

An IPM approach seeks to minimize the long-term economic and environmental costs of pest control. The following pesticide-use alternatives are consistant with an IPM approach.

i) For emergency locust control operations where the use of pesticides is unavoidable, consider the possibility of establishing a pesticide bank in southern Europe with pre-purchased renewable stores. These will be able to be rapidly deployed, will cover a greater area with fewer stocks, and will assure a fresh supply of chemicals. This approach also reduces exposure of chemical stocks to harsh storage conditions on the African continent.

ii) The objective of grasshopper control should be to protect crops, and farmers should be the first line of defense against grasshoppers. Farmer brigades have shown themselves effective in the use of low-concentration dusts (e.g., propoxur 2%) and ULV battery-operated sprayers. Under certain restricted conditions, farmers may be able to significantly reduce local populations by destroying egg-pod fields. Above a certain threshold--based on potential crop loss, grasshopper density and crop maturation--national CPS ground equipment (back-pack and truck-mounted sprayers) should be used to combat grasshoppers.

iii) Treat local concentrations and small outbreaks of locusts early with ground equipment, where feasible, and small planes where required for access, efficiency and safety. This "strategic" approach conforms to the objectives of IPM by scaling the treatment to the needs. This limits the economic and environmental costs of treating larger areas than need be treated due

to a suboptimal choice of application equipment (e.g., large planes). Small planes may be required, where ground equipment would otherwise suffice, if roads are impassable or populations too distant.

iv) Treat strategic populations of desert locust as soon as gregarious bands or swarms are detected, even if the populations are in remote areas, and unlikely to immediately threaten host-country crops. As discussed earlier, treating nascent populations of locust before they multiply and escape is in everyones best interest. Today's small swarm could be tomorrow's outbreak, which will eventually return, requiring greater effort and expense.

2. Evaluate viable alternative pesticides and formulations used in wide area (large plane) applications, baits, barrier treatments and ground or aerial applications.

a. Pesticide testing for wide-area (large plane) applications was conducted under the AELGA project by Dynamac.

The purposes of the Dynamac trials were: i) to evaluate a range of pesticides for efficacy against desert locust and grasshoppers; ii) to test their impact on non-target and beneficial organisms; and, iii) to test for chemical residues in soil and on vegetation.

Efficacy and environmental impact trials were conducted in Mali in 1987. In Sudan in 1988, the impact trials were completed, but the efficacy trials were abandoned in due to start-up delays.

The Dynamac studies are deficient in many respects, from research methods, through implementation, to analysis and exposition. First, the phase I (small plot) efficacy trials in Mali had to be repeated due to problems with calibration of the Micronair ULV applicators. This would probably not have occurred if an experienced aerial applications person had been on the team. (Phase II did have the benefit of such an expert.) Moreover, the final results of these trials are open to serious question because treatment plots may have been too close together. In other words, because the Senegalese grasshopper is fairly mobile, grasshoppers sprayed in one plot could well have died in another plot, or outside the treatment plots altogether, while unsprayed grasshoppers could have moved onto the plot. The Dynamac team was aware of this obvious problem and placed more reliability on the 24 and 48 hour post-treatment counts than on the 7 day and 14 day counts, since the likelihood of significant grasshopper movement increases with time. But, clearly, the mistake of not widely separating research plots had already been made.

Second, the large-scale (phase II) trials were intended to test the most effective subset of chemicals from the phase I trials for environmental impact. The murky results from phase I showed all eight chemicals equally efficacious. (Karate fell slightly below the others, possibly due to rainfall immediately after application.) As a result, USAID suggested that all eight chemicals be used in the phase II trials. Dynamac, however, chose to stick to the original protocol and test only four chemicals in order to maintain

a reasonably simple experimental design. One chemical from each of the major pesticide groups was chosen, plus Malathion as a control (i.e., chlorpyrifos, and organophosphate; Lambda-dyhalothrin, a pyrethroid; and Carbaryl, a carbamate). In addition to the impact and residue tests, phase II reevaluated the efficacy trials for these four chemicals. This design was not subject to the problem of grasshopper movement since one kilometer square plots were used with a minimum of 0.5 kilometers between them. The phase II results corroborated those of phase I.

Third, the environmental impact studies in Mali on non-target organisms were unsuccessful because: i) non-target insect populations are at very low density, and hence difficult to sample with statistical reliability; and, ii) little is known of their biology, hence the timing and nature of required sampling methods are unknown.

Because of Dynamac's experience in Mali, the impact trials in Sudan were marginally more successful. In the Phase I trials, beneficial insect groups were the focus of the samples. However, sampling methods were not sufficient, and population densities were too low for a statistically significant sample to be obtained. In Phase II, the team sampled a wider variety of insect groups, both pre- and post-treatment, and with additional controls (double control tests). Almost needless to say, one expects--and demands--that researchers be experienced enough to anticipate and avoid such flaws in research design.

Fourth, the results from the residue studies were compromised (but not rendered entirely useless) by the temporary loss of the samples between London and Miami. As a result, the samples thawed, and the amount of residue detected was undoubtedly less than it would have been otherwise. Fortunately, the samples from the Sudan trial were not compromised. Analysis of these samples supports the conclusion that, with the exception of bendiocarb, all the tested chemicals break down rapidly in the environment to levels well below those required by the US EPA. (Six chemicals were tested in Sudan.) In Sudan, however, only the impact and residue trials were done since, due to logistical delays, the locust habitat had dried up and test insects were not available in sufficient densities to be able to conduct the studies.

The overall research design and implementation are also seriously flawed in other important ways. First, the Malian research agency, the Section de Recherche sur les Cultures Vivrieres et Oleagineuses (SRCVO), was not invited to work in collaboration with Dynamac. A SRCVO agent was contacted at the last minute to help coordinate logistics and to perform translation tasks. (None of the members of the Dynamac team spoke French.) But, understandably, the feeling in SRCVO is that they did some very important work for the trials, but were not asked to participate in the analysis, and have received neither recognition nor even copies of any of the reports. This evaluation team deplores this evident lack of professional and scientific courtesy.

Second, the Dynamac trials were to have continued for a second year, had Dynamac provided a report on the analysis of their first-year results. In that instance, USAID could legally waive the requirements for a competitive bid. Almost unbelievably, Dynamac failed to provide this research report, with the necessary result that the follow-

on work was not carried out. Thus, important research was derailed, and the investment made by AELGA largely lost.

This sad saga necessitates three basic recommendations. First, only qualified researchers with country experience should lead the collaborative effort with the national research agency. In the present instance, the contractor was inexperienced with the biology of the animals and with the logistics of working in Africa. These problems can be mitigated by better coordination and integration with host-country research personnel. **If any future work is to be done, the national research agency, as well as the national crop protection service, must be integrated fully into the planning, execution and analysis phases of the research.** Such collaborative research efforts are excellent training opportunities, and constitute a major input for institutional development. US technical assistance might well be needed for aerial application and calibration, for sampling design, and for chemical residue analysis of biological and soil samples. (This last task might be done through a local or regional residue lab.) However all such tasks could, and should, involve African counterparts, and possibly even short-term training programs. Further, these recommendations require that research not be solicited hastily, and that research contracts be reviewed by qualified scientists.

Second, any contractor assessing the impact of pesticides on natural populations of insects must be given the time, before the trials begin, to investigate these insect populations in order to develop baseline data on insect species and their typical life cycles. This would be an excellent task for the host-country research people, perhaps in conjunction with a US university.

Third, it must be insisted upon that any work done by US contractors be reported in a timely and professional manner. Further, all reports must be translated into French, and sent to the appropriate USAID for distribution to the participating national agencies.

b. Baits and barrier treatments

Baits and barrier treatments are important alternatives. Farmers have an important role to play in protecting their own crops from invasions by grasshoppers and locusts. However, crop protection service directors expressed concerns over the formulation, storage, and use of chemicals and baits by farmers. Given the problems in these areas encountered by the CPSs themselves, these concerns are well-founded.

Baits and barrier treatments pose great risk of accidental poisoning of people and especially of livestock. French and English technicians found during earlier plagues that barrier treatments are an effective and a conservative use of pesticides. Unfortunately, this work, though successful, used dieldrin against hopper bands. The same application techniques might be employed if an alternative chemical agent could be found that was sufficiently long lived, but neither as long-lived nor as lipophilic as dieldrin. In brief, research in this area could repay important returns.

c. Ground or aerial applications

Ground or aerial applications are the usual tactics for locust control. Ideally, nascent outbreaks will be controlled by ground crews whose primary mandate is crop protection. This ideal is not yet consistently possible. Thus aerial application is the only effective control in certain circumstances such as swarms and hopper bands covering large areas or in inaccessible strategic regions. Even so, the PEA suggests that under no circumstances should large-plane aerial application be carried out, and that only small planes be used for precision treatments.

A major long-term effort must therefore be made to support and sustain the ground-control capabilities of the national CPSs. The justification is that effective ground-control can cover most crop protection needs, given there also exists effective forecasting and ground-survey capabilities (Section III E). Nevertheless, it is equally necessary to conduct survey and control operations in the remote and often inaccessible strategic areas, and this topic requires serious consideration. **Finally, with regard to alternative chemical techniques, the potential of slow-release insecticides and "pesticide cocktails" (i.e., malathion plus a synthetic pyrethroid) to achieve rapid knockdown and subsequent kill should be explored because this work will refine chemical control technologies.**

3. Evaluate the potential for new or improved control technologies (e.g., Neem, nosema bait, other pathogens, parasites, crop varieties and alternative crops, and mechanical methods.

The AELGA project correctly identified and supported several pertinent research areas, including the use of biological control or "bio-rational" methods of insect control. These and other possibilities--neem, Nosema and other pathogens, parasitoids and predators, crop varieties and alternative crops, and mechanical methods--are considered below. **The fundamental point is that while the research endeavors selected are important and worthwhile, the research has been very poorly done. AELGA must therefore institute a peer review process for research selection and supervision and exercise must closer scrutiny and control over the research it is financing.**

a. Neem research

Neem research examines the antifeedant effect of neem kernel extracts on West African grasshoppers. Research over the past ten years has shown that the extract from neem tree fruits (Azadirachta indica) has a significant antifeedant effect (i.e., causes the cessation of feeding) on many insects. Under AELGA, field trials were conducted at the ICRISAT field station near Niamey, Niger. The research was conducted by the Agency to Facilitate the Growth of Rural Organizations (AFGRO), a subcontractor to the University of Minnesota, which was in turn a subcontractor to the Consortium for International Crop Protection (CICP). Total funds obligated to the neem contracts are $195,677 for work through September 30, 1989.

While neem research is valuable, the particular studies funded by AELGA appear misdirected. The neem SOW stipulates a two-year evaluation of the efficacy of neem-

seed extract against locusts and grasshoppers in an agricultural setting in Niger. The two main lines of research were: i) the assessment of the bioactivity of the extract against Sahelian species of grasshoppers; and, ii) the socioeconomic feasibility of neem kernel extract (KNE) production at the village-level. Neem extracts present exciting possibilities for pest suppression due to high antifeedant properties, and to the fact that insect pests have not yet shown genetic resistance to the active neem ingredient (H. Ostermann, pers.com.). However, the appropriateness of the research within the context of protecting cereal grains from grasshoppers and locusts is questionable for the simple reason that not enough neem trees are found within Niger to make the treatment of large areas of cereal grain feasible. (There also is a major labor constraint, which is discussed below.) For this reason, the long-term work on neem extracts by the German research team financed by GTZ has focused exclusively on protecting vegetable crops from a wide range of pests.

Moreover, the AELGA-financed neem research has only partly attained its goals. The first year's work (August-September 1987) involved small cage experiments to test if Neem had antifeedant effects against Kraussaria anguilifera, a principal grasshopper pest in West Africa. Some of the work was professionally done (Radcliffe et al.). But the presentation of results leaves a great deal to be desired. Graphic presentations, instead of tabular data, would have made the report more readable and indeed more comprehensible even to the scientific reader.

The second year's work (1988) involved field testing of various dosages and treatments, plus a sociological assessment of farmer acceptance of neem application technologies. Although the sociological report is not yet available, the study reportedly identifies important constraints on the use of Neem for cereal grain protection. Specifically, farmers are unwilling to invest either the time or the money required to use this extract on their subsistence crops. Moreover, the applications take place just when the farmers have least time available. These constraints do not bode well for the general use of neem extract on cereal crops (H. Ostermann, pers.com.).

The field tests (Mission report by Habib Khoury, October 1988) were generally a failure for a host of reasons, both intrinsic (design) and extrinsic (environmental). The design failures involved difficulties in quantifying levels of damage by grasshoppers on millet. Leaf damage was chosen as an indicator of feeding preference, and several methods were tried before settling on a qualitative visual classification. Unfortunately for the selection of this indicator, foliar damage undoubtedly has a nonlinear relationship with actual yield loss, i.e., at low and moderate levels of defoliation there is probably little or no loss in grain yield. Further, evaluation of damage to millet heads was too low to provide contrasting results, both in field and in cage trials. The question again arises: to what degree do grasshoppers cause yield losses in millet? If grasshoppers and locusts are an infrequent and sporadic pest, and if farmers do not have a history of applying time, labor and expense towards pesticide applications on millet, this research should be considered inappropriate.

The presentation of the Khoury report is poor. The CICP-University of Minnesota subcontract specifies that: "The principal investigators are encouraged to prepare their

research findings in a format suitable for publication in professional journals." The Khoury report does not follow these guidelines. It presents its results in 17 tables of means, with no calculated variances and no graphical summaries of the data. Due to the lack of variance estimates, researchers will not be able to evaluate the significance of the results. And, due to the obtuse presentation, concerned generalists such as USAID mission personnel and host-country nationals will have great difficulty in extracting the general results.

Finally, this research effort did not sufficiently incorporate local research personnel in project design and execution for the entomology trials. (The sociological study did involve host country national participation.) The evaluation team believes such collaboration, important in and of itself, would also help avoid many of the technical difficulties encountered by inexperienced expatriate research teams.

The proposal for continued research in 1989 (Strzok letter of March 7, 1989) suggests that tests of Neem efficacy against locusts and grasshoppers will continue. The field sites will be in Mali, and the trials will be conducted over a ten-day period in April, with the team working through the crop protection service. Any follow-on work should take into account the following recommendations.

One, all research efforts must involve host-country participation at all stages, from design, through experimentation, to analysis and write-up. The crop protection service in Mali, although one of the best in West Africa, is not a research organization. The team should make contact with the Ministry of Agriculture through Dr. Yacouba Doumbia, entomologist with the Malian Section de Recherche sur les Cultures Vivrieres et Oleagineuses, Chef de la Cellule Defense des Cultures.

Two, the principal investigators should present a justification to project management as to why it is appropriate to continue to focus on cereal grains given the negative results in Niger, i.e., that not enough neem exists to begin to treat significant areas, and that farmers are unwilling to take the time, effort, and expense to protect millet from grasshoppers in this manner. If it makes more sense to look at protecting vegetable crops, the project should shift its orientation. In Mali, certainly, vegetable gardening is a widespread occupation, often involving the misuse of large quantities of pesticides. Neem could well be a successful alternative.

Three, project management must insist that all reports be produced in a format generally acceptable to professional journals, and easily accessible to concerned generalists, that is, with summary statistics, analyses of variance and graphical presentations. These reports must also be furnished to the appropriate USAIDs and to the concerned national agencies on a timely basis.

b. Nosema baits and other pathogens

Nosema baits and other pathogens have been correctly identified by AELGA as methods with a high potential for success in controlling both desert locust and Senegalese grasshopper.

Locusts and grasshoppers feed, migrate and breed, often in very high densities. Hence, introduced disease agents could succeed as a type of "biotic insecticide". These agents are highly specific organisms, especially evolved to attack one or a few species of acrididae, so the impact on human and other animal life is nil. In environmentally sensitive areas, such as the inland delta of the Niger river in Mali, where a large proportion of the European migratory birds overwinter (PEA page D-44), control of overwintering populations of the African migratory locust with an effective biological control agent would clearly be preferable to large-scale use of broad-spectrum insecticides.

Under AELGA, research trials on the grasshopper pathogen Nosema locustae ("Nolobait") were attempted in Mali in 1988. The Nolobait trials in Mali failed for unforeseeable reasons. The location for the trials had been decided upon, materials had been purchased and put in place, and an aircraft had been hired. In all, $220,000 was spent in preparation costs. Then, at the last minute, the trials were interrupted and later cancelled in order to give the Malian government sufficient time to determine whether N. locustae constitute a toxic health hazard to humans and animals. It is likely that little could have been done to prevent the abortion of these trials. Toxic waste disposal on the west coast of Africa has sensitized governments. The president of Mali, now also acting president of the OAU, is acutely sensitive to the issues. And, a change occurred in the personnel in Malian ministries. All this resulted in a sudden high sensitivity to the possibility that insect diseases may represent a toxic hazard. Such a confluence of political events was unforeseeable. However, it is also true that these trials were set up without the involvement and cooperation of the Malian research division; contact was again made only with the national crop protection service.

The use of N. locustae for controlling grasshoppers in the US has been studied for over 20 years by the USDA. Controversy still exists within the U.S. academic and agricultural research community over the success of these studies. The opinion of many experts in the field is that N. locustae is simply not sufficiently virulent to be an effective control agent. Early trials with N. locustae in Senegal and Cape Verde under the Regional Food Crop Protection project in the early 1980s showed little promise of this agent being effective on West African grasshoppers.

On the other hand, potentially more virulent and possibly more environmentally stable pathogens are now being studied. Indeed, pre-proposals and proposals have already been submitted to AFR and S&T. These (CICP pre-proposal, Feb. 6, 1989, and Rangeland Insect Lab. proposal, August 17, 1988) might be considered for funding under AELGA, assuming that they are scientifically sound and well planned. Among these new candidates is Nosema cuneatum, a North American protozoan that has been shown to have high virulence against some West African species, including African migratory locust. Other agents (e.g., entomopox viruses) may be the most promising biocontrol agents for use on grasshoppers and locusts, but these viruses are not yet registered by the US Enviromental Protection Agency (EPA) for experimental use.

In this situation, the team makes four recommendations. **One, a definitive test should be carried out on N. locustae in 1989 to determine whether or not it is capable of controlling Senegalese grasshopper.** The contractor should have experience with the logistical and methodological problems of doing such tests in Africa. A successful protocol for doing these tests should be considered the most important outcome from these trials, since, even if N. locustae is shown to be ineffective, an established methodology will exist for testing the potential of other pathogens.

Two, Nosema cuneatum should be tested during these same trials with N. locustae. If the project is extended beyond the current projected timeframe, testing of other pathogens should be a high priority. The scope of work should be expanded to include tests of pathogens against locust.

Three, project management must insist that all reports be produced in a format generally acceptable to professional journals, easily accessible to host-country and USAID mission personnel, and with summary statistics, analyses of variance, and graphical presentations, such as error bars.

Four, all research must involve host-country national research participation at all stages, i.e., planning, implementation, analysis and reporting. All reports must be translated into either French or Portuguese, and distributed to all interested parties in a timely manner.

c. Parasitoids

Parasitoids and predators are inappropriate subjects for AELGA. Migratory pest species such as locusts are poor targets for classical biological control introductions (i.e., the use of predatory and parasitic natural enemies). Natural enemies that can cause high mortality in solitary locust and grasshopper populations are ineffective against gregarious locust populations. Although insect natural enemies (especially egg parasites) are capable of causing heavy mortality on natural populations of locusts, there is no evidence that they prevent outbreaks.

The Senegalese grasshopper exhibits only limited migratory behavior within a habitat (Sudano-Sahelian zone) that receives rainfall on a fairly regular basis and, hence,is more biologically diverse than the habitat of desert locust. Therefore, natural enemy populations may play a key role in the regulation of Senegalese grasshopper populations. Nevertheless, the use of parasitoids or predators to control Senegalese grasshopper is probably not an alternative with much chance of success. Augmentative or inundative release of natural enemies is not feasible since the natural enemies would have to be raised on grasshoppers, and the numbers required to have any impact would be unrealistically large.

This is not an appropriate subject to be pursued under AELGA since the likelihood of their effective use as control agents is small.

d. Crop varieties

Crop varieties and alternative crops have not been, and here are not considered appropriate, topics of investigation under AELGA. ICRISAT is currently breeding varieties of millet that are resistant to attack by various key pests in the Sahel, such as the spiral head borer. The spiral head borer consistently causes significant damage to millet, and resistance might be imparted by selecting for strains of millet whose grains are very closely packed. This approach is unlikely to work for grasshoppers and locusts since they cause, on average, much lower levels of damage, and resistance to their attack would probably entail drastically changing the taste of the grain. The result would likely be that people would refuse to eat the grain while the locusts might well munch on it anyway--an approach unlikely to please African farmers.

Alternative crops make no sense given the fact that so few crops are sufficiently drought-resistant to be grown in the Sahel, and since grasshoppers and locusts, especially when in large numbers, are polyphagous, that is, they eat anything. This subject should not be pursued under AELGA.

e. Mechanical methods

Mechanical methods include the use of farmer-dug trenches surrounding fields, "corrals" to which hopper bands are directed to a central point for destruction, and the digging up of egg pods. Evidence from crop protection services in several countries suggests that farmers have had some success in locating and digging up local egg-pod fields for Senegalese grasshopper. This method will only be successful in certain restricted cases, i.e., where dense populations are restricted to very limited areas and where egg pod fields have been definitely identified. The use of trenches may provide a last-minute reprieve for crops from a marching locust-hopper band. But if infestations of any size are encountered, the method will quickly fail.

The destruction of egg-pod fields by farmer brigades should be encouraged. The strengths and limitations of such methods should be explored with local crop protection personnel, and incorporated into farmer training programs. In should be remembered in this regard that a large proportion of the farmers in the region are women, and that the agricultural extension services have not been particularly effective in dealing with this segment of the farming population. Also, it should be noted that these methods, possibly important for crop protection, are not feasible for strategic locust control.

4. **Evaluate the increased use and sophistication of various technologies for survey, detection and modeling, greenness maps, host country plant pest services, missions, regional organizations, and FAO.**

In the long-term, the costs of locust control operations, as well as their impact on man and the environment, will be minimized by intervening earlier in the locust plague cycle. Early intervention requires forecasting, ground survey, and ground-based treatment capabilities. A successful program for locust early warning is technically feasible, but will require: 1) well trained and equipped national crop protection services with efficient survey and reporting capabilities; 2) a regional organization to effectively gather national survey reports, synthesize a regional picture, and disseminate status reports and alerts; and, 3) a forecasting center with communication links to regional and national centers.

A. Forecasting. The purpose of forecasting is to identify areas currently at highest risk of supporting locusts, and thereby limit the area needed to be surveyed by national CPS teams.

Vegetative growth is the most important indicator of locust risk. Consequently, the greenness maps have been invaluable tools during the current plague, greatly increasing the efficiency of scouting operations. Other types of data can, in principal, be added to the greenness maps to further increase the precision and accuracy of the risk determination.

There are four general categories of information involved in locust forecasting. Within each category, there are one or more methods currently available to acquire the information. The categories and methods are listed in outline below and discussed in the same order in the text that follows.

1. Habitat suitability (where locusts can develop)
   a. vegetation ("greenness") maps
   b. synoptic weather station data
   c. cold cloud duration maps
   d. maps of vegetation and soil types preferred by locusts

2. Locust distribution (where they are currently found)
   a. current survey reports from the field
   b. historical data on swarm distributions

3. Locust development (how long until they become adults; temperature driven growth-rate submodels)

4. Locust movement (where will they go; wind-field maps)

1. Habitat suitability. Locusts exploit intermittent rainfall and subsequent vegetation growth in arid environments. The amount of rainfall necessary for the germination of ephemeral vegetation is also sufficient for locust egg hatch, growth and reproduction. Hence, meteorological data are the backbone of locust forecasting, particularly for desert locust (Shistocerca gregaria), the most wide-ranging migrant whose breeding grounds are least constant from year to year.

a. Greenness maps. The NOAA series of polar-orbiting satellites, carrying the Advanced Very High Resolution Radiometer (AVHRR) sensor, have been operational since 1979.

Vegetation indices, or "greenness maps," are derived from measurements of visible and near-infrared radiation. Under AELGA, the USGS EROS Data Center has been produced greenness maps for West Africa. (Senegal, The Gambia, Mauritania, Niger, and Chad have received the maps since 1987; other countries in western and northern Africa may be added.) The maps are derived from two-week composites of daily NOAA satellite data, and use one-kilometer resolution Local Area Coverage (LAC) data to compute a Normalized Difference Vegetation Index (NDVI) whose values relate to the amount and vigor of green vegetation. In the near future, it will be possible to overlay the vegetation data with other types of data (e.g., soil maps and wind-field maps) within a geographic information database.

During the 1987 and 1988 outbreaks, the national CPSs found that greenness maps alone served a useful function in delimiting areas potentially favorable to locust breeding and development. Greenness maps were unanimously praised, by both USAID missions and national crop protection services, for their utility in helping to locate areas where rainfall had produced favorable habitat for locust breeding. The major criticism of the maps was the delay in receiving them in the field--an eight-day lag in 1988 (down from 2 weeks in 1987). The possibility of reducing the maps to an 8x11 inch format and transmitting via fax machine is being implemented in order to reduce further the lag time.

The timely delivery of greenness maps may be the only essential element in any forecasting operation. However, given that a forecasting operation has the capability of producing greenness maps, the additional elements discussed below may add to the precision and accuracy of the forecast.

b. Synoptic weather data. Synoptic weather data are collected from ground-based weather stations, and include measurements of rainfall, temperature, and wind speed and direction. AGRHYMET agrometeorological stations may, in time, provide additional data (e.g., soil moisture and soil temperature). Unfortunately, recording stations are few in number and irregularly distributed with only a few stations located in the extremely arid locations that are of particular interest with regard to desert locust breeding. Also, AGRHYMET's problems are various, including electric power outages, incomplete reporting records, difficulties in maintaining computers, and unreliable communication gathering and dissemination. In any case, synoptic data are inadequate

for forecasting because the small number of locations will often miss the highly localized and unpredictable rainfall occurrences in the zones of interest. Before the advent of greenness maps, favorable areas for breeding were most often located by ground survey. Some thought is now being given to the placement of solar-powered "robot" weather stations, but these are expensive, especially in light of the vast land areas in question. And no matter what, the bottom line is that synoptic data alone are inadequate for forecasting locust.

c. Cold cloud duration (CCD) maps. Remote sensing technology has recently advanced to the point at which the measurement of cloud-top temperatures can be correlated with the likelihood of rainfall. While the accuracy of (CCD) maps is variable over short time periods (24 hours), the long-term CCD maps (10 day and 30 day) are said to be more accurate. FAO's ARTEMIS system currently constructs 10-day and 30-day rainfall maps derived from CCD data, captured from the METEOSAT satellite. CCD maps are currently in the research phase, and no published data exist to prove the accuracy of the correlation. Eventually, CCD map technology may give users an increased lead time over greenness maps, as well as a quantified measure of rainfall. However, currently it is not clear that the CCD maps offer any additional information to greenness maps.

d. Vegetation and soil types preferred by locusts. Maps derived from surveys by locust experts, such as George Popov, identify areas suitable to the breeding and development of locusts and grasshoppers (given sufficient rainfall). In the 1960's Popov surveyed much of Sahelian West Africa to produce soil maps that indicate preferred egg-laying sites for the Senegalese Grasshopper Oedaleus senegalensis. A "preferred vegetation" map has recently been completed by Popov for the desert locust. These maps are not, in and of themselves, sufficient for forecasting. But these maps can be overlaid on greenness maps to further prioritize scouting efforts based on likely locust risk.

2. Locust Distribution.

a. Current survey reports from the field. While greenness maps and other data provide invaluable clues to survey teams in the field, it is critical that the information flow from the field to the forecasting center as well. Currently, many field survey teams have truck-mounted two-way radios in order to communicate survey findings to regional (in-country) bases. However, there is an overall lack of trained field survey personnel, and no standardized data survey form. Most importantly, there is no regional organization in West Africa that is capable of coordinating survey data gathered from the various countries, and of then transmitting these data in a timely manner to a regional forecasting center. The recent restructuring of OCLALAV may alleviate this problem since this task comes under their new, more restricted mandate.

b. Historical data on locust swarm distributions. The analysis of historical data on past locust plagues may provide important clues concerning general patterns of plague outbreaks, and increase the general understanding of locust movement. FAO/ECLO has

entered the data from past plagues on their computers and plans to analyze the current outbreak in the near future.

3. Locust Development. Temperature-driven growth-rate submodels are simple and important elements of locust forecasting. These submodels calculate how long, once sufficient moisture is available, until egg hatching occurs, and until larvae reach the winged-adult stage. Insect growth is fairly directly related to ambient temperature, and these temperature-growth models have long ago been worked out for the various species of locusts and grasshoppers. These submodels would essentially provide the "window" within which scouting must occur. Before a specified time nothing will be seen since eggs have not hatched. After a specified time one risks having the adults migrating to new areas.

The conditions under which solitary locusts become gregarious have yet to be understood. These conditions involve not only intrinsic locust biology, but also extrinsic factors like the suitability and architecture of the vegetation (Roffey, pers.com.). It is unlikely that this level of detail will be incorporated into a forecasting model. Hence, critical questions of whether locusts in an area are solitary or gregarious, and whether they are likely to stay for another generation or move on, can only be answered by field-scouting.

4. Locust movement: wind-field maps. Wind-field maps are another recent technological development which has potential for greatly assisting the locust forecasting effort. Wind-field maps are computer generated graphics that synthesize various sources of data on lower-level wind patterns. These data sources include synoptic weather stations, time-series calculation of cloud movements as measured by METEOSAT satellite imagery, and high-altitude jet stream monitoring from ASECNA stations. The outputs are, as with greenness maps, intuitively accessible graphics which project forecasts of wind streams and eddies, up to five days in advance. The Dutch company Meteoconsult will be providing the data analysis and graphics software to the FAO/ARTEMIS/ECLO operation in 1989. Knowledge of wind patterns, when coupled with locust survey reports from the field and greenness maps, may provide an advantage to forecasting by providing an early warning of where swarms are likely to be heading.

B. Current and Future Locust/Grasshopper Forecasting Projects

There are several institutions that conduct, or are planning to conduct, locust and/or grasshopper forecasting operations. These include: the FAO with its ARTEMIS/ECLO project; PRIFAS, which is a French research agency; and AGRHYMET, a CILSS meteorology agency.

1. FAO/ARTEMIS/ECLO. FAO is the furthest along towards establishing a functioning locust forecasting system. Since 1976, the FAO remote sensing center has been developing and testing the Global Information and Early Warning System (GIEWS). One of the operational systems within this program is the African Real Time

Environmental Monitoring and Information System (ARTEMIS), which provides data acquisition and analysis for the Emergency Committee for Locust Operations (ECLO). The core elements of ARTEMIS are greenness maps, cold-cloud duration maps, and wind field maps. All of these systems are being or will be installed at FAO in Rome. The hardware to produce greenness maps and to manipulate the data has been received, but the equipment necessary to produce the actual glossy maps has yet to arrive. FAO/ECLO expects to have this capability by 1990. Cold-cloud duration maps are currently on-line, but this proxy technology is as yet unproven. Finally, the software for the wind-field maps is expected to be integrated into the ARTEMIS system this year.

Data capture from NOAA and METEOSAT satellites and subsequent processing are almost wholly automated. ECLO can download rainfall and vegetation images onto personal computers (PCs) from the main computer. On ECLO's PCs, additional "layers" of information will be integrated and overlaid, within a geographic information system (GIS) format, as they become available (e.g., wind-field maps,survey data, historical survey data, soil and vegetation quality maps).

There are four problems with the FAO/ECLO system that warrant mention. First, the spatial scale of resolution for the greenness maps is a 8 km^2 pixel, compared with 1 km^2 pixel for the greenness maps from EROS. The expert opinion is that this scale is not adequate for detecting greenness in many small, but important, areas such as wadis.

Second, the FAO greenness data lack geographic references (location indicators). These maps have no major and minor political boundaries, roads, topographical features, or the like. Hence, they are not adequate for use by pilots and survey teams at a national scale.

Third, it is ECLO's mandate, among other things, to produce a timely locust reporting bulletin to be sent to the interested African countries. Currently the bulletin is sent by telex, which means that national CPS do not benefit from the graphic potential of the system.

A proposed operational system within GIEWS may partially address the problem of dissemination of forecasting data to the field: the Data and Information Available Now in Africa, or DIANA project, proposes to downlink the ARTEMIS/ECLO database to regional bases in Africa. The proposed pilot downlink locations are the AGRHYMET center in Niamey, and similar institutions in Nairobi and Harare. Even if these downlinks are established, FAO is still faced with problems of dissemination to the surrounding African countries.

Fourth, FAO, in concert with all the other forecasting projects, lacks timely, systematic and standardized reporting from the field. Currently, ECLO receives information from FAO representatives in each country who are members of the donor coordinating and technical committees. The quality and timeliness of the data from the field are a function of the host-country's survey capabilities. In Sudan, FAO was this year obliged

to send someone from Rome to mobilize local survey teams in order to evaluate the predicted threat. The solution to this critical problem is increased institutional development of local crop protection services and of African regional organizations such as OCLALAV and DELCO-EA.

2. PRIFAS. The PRIFAS model was first constructed for the Senegalese grasshopper, (OSE;Launois 1978). This model is based on the qualitative vegetational and soil maps of Popov, synoptic weather data from AGREHYMET meteorological stations, submodels for growth and development of the grasshoppers, and on hypothesized general migration patterns. In the past two years, PRIFAS has been contracted to establish a model for desert locust based on similar inputs.

The PRIFAS model is an inadequate forecasting tool for four reasons. One, synoptic weather data and qualitative vegetation and soil maps, while useful ancillary tools, are not in themselves an adequate core data set for forecasting desert locust outbreaks. The PRIFAS model tries to compensate for the sparse distribution of synoptic weather stations by interpolating rainfall conditions between stations, using 30 year averages. Given the highly variable nature of rainfall in the regions, in both time and space, this can only be a rough approximation at best, and cannot address the fundamental forecasting need--identification of precise geographic locations recently subject to favorable rainfall.

Two, the model requires numerous, diverse and detailed data sets on ecological factors. These data do not exist. Thus, model outputs are vague and uncertain. Third, the understanding of the biology of the Senegalese grasshopper is incomplete. Decision rules of the model are based on biological details which have been shown to be questionable or false (e.g., Fishpool 1977).

Fourth, the PRIFAS early-warning bulletin (SAS) suffers from a one-way flow of information: Montpelier to Africa. There is little effort made to acquire data from the field, or even from remote sensing systems, during the course of the season. Aside from the fact that the forecasts were most often clearly wrong, they are also invariably late.

Reception of the PRIFAS forecasting newsletter (SAS bulletin) by national CPSs and USAID entomologists has been mostly negative. One CPS director did indicate, however, that these newsletters could be useful since any clue as to where to look for grasshoppers was better than none.

3. AGRHYMET (Agro-Hydro-Meteorology). Currently in phase III, the CILSS AGRHYMET project is receiving substantial assistance through USAID, and may develop a regional locust forecasting center. Since September 1988 the French have been testing a newly constructed satellite dish that will be capable of receiving NOAA AVHRR data from which greenness maps are constructed. The USGS is stationing three technicians in Niamey to help with the generation of greenness maps and regional workshops.

Training in vegetation index interpretation continues to be carried out by EROS Data Center.

AGRHYMET has proposed a five-year program entitled: "Acridometeorologie Operationnelle" (AMOPER), a proposal directed toward: 1) establishing a data base for forecasting; 2) training of mid-level operations staff, and upper-level research staff, in locust ecology and control methods; and, 3) research. The project's field operations will use the old CILSS/IPM observation posts, staffed initially by African personnel from the CILSS member states who have been trained under previous projects such as the earlier CILSS/IPM project. The project proposal suggests that AMOPER will provide forecasting information for the member states, based on the development of greenness maps and detailed studies of ecological and meteorological factors influencing locust population dynamics. Forecasting will be based on survey results and meteorological data transmitted to Niamey from the various observation posts.

An advantage of this project, over the PRIFAS effort, is the use of greenness maps, and possibly METEOSAT data (CCD maps). An advantage over the FAO/ARTEMIS program is the emphasis on field observation and verification and rapid communications of survey results to Niamey.

Disadvantages of this project begin with the fact that AGRHYMET, now in Phase III, has not yet developed a communications network adequate to serve forecasting needs. Communications from the member meteor stations are slow to reach Niamey, and there distribution of information back to the countries is even slower. Computer equipment in the various substations was often poorly maintained.

While greenness maps will be produced in Niamey, probably in the next three years, there is no assurance that any of the other elements of a forecasting program will be on-line by this time. Finally, there is an expressed interest in using the PRIFAS ecological model. USAID should carefully consider what its role might be in supporting forecasting through AGRHYMET. Overly complex computer simulation models with unrealistic data demands will not provide a good return on the investment. Elements of a successful forecasting operation are simple: timely and reliable field and remote-sensing data, and excellent two-way communications with the national crop protection services.

C. Summary. The elements of a successful forecasting operation exist, but the lines of authority and communication, as well as the role of regional institutions, have not been well defined. AELGA has supported two activities related to forecasting: the greenness maps furnished by the EROS Data Center between 1987 and 1989; and the ECLO institutional support, which supported technical assistance in survey and equipped the regional ECLO offices. In view of this assistance, the team recommends that:

i) **AELGA continue funding the greenness maps under the mission buy-in or another system**, at least until AGRHYMET is able to take over this task; and,

ii) **AELGA fund one long-term technical assistant for forecasting; for FAO ARTEMIS/ECLO under a USDA RSSA or an IPA.** This is important both because forecasting technology, under FAO ARTEMIS/ECLO, is logically directed and technically sound, covering each of the areas of forecasting needs, and because the FAO program is the farthest along in being implemented. Also, the US has an excellent pool of technical experts which might be useful to ECLO, including entomologists, mathematical ecologists and computer modelers. And, finally, technical assistance to FAO ARTEMIS/ECLO would strengthen ties between the U.S. and FAO Rome, and be a useful liaison during future outbreaks, and for other remote sensing projects in general.

5. **To assess the technology developed under aelga (including entomological and environmental considerations) to measure crop losses for economic cost-benefit analysis of grasshopper and locust control.**

The Programmatic Environmental Assessment (PEA), section c.2 entitled "Impact of Locust and Grasshopper Outbreaks", presents a good overview of the little data exist on actual crop losses due to locusts and grasshoppers in Africa. The bottom line is that almost nothing is known.

Under AELGA, an "Economic Analysis of African Locust/Grasshopper Control" was subcontracted to Oregon State University's International Plant Protection Center (IPPC), through the intermediary of the Consortium for International Crop Protection (CICP). The original contract, to begin September 1987, was for $274,272, and was to end one year later. In August 1988, AELGA project management was informed that the work was not complete, and a request for a one year, unfunded extension was made. In September 1988 the scope of work was amended to include additional salary for a modeler, benefits, services and supplies and round-trip travel to Chad, at an additional cost of $21,617.

A major problem in the scope of work for the PIO/T, "Economic Analysis of African Locust/Grasshopper Control," is the unrealistic notion of what could be accomplished in the field. Specifically, the types of data required for the model are unavailable in the field, or at best fragmentary. As a result, the types of analyses generated by such a model would be so uncertain as to be unusable, or worse, misleading. Buried within the overly ambitious SOW were two elements, which would have generated useful results. These are: current costs and extent of coverage of ground and aerial application, and estimates of crop losses. A third necessary element is a map of crops in the afflicted countries, along with a cropping calendar, so that the extent of risk or agricultural vulnerability can be assessed.

The SOW elaborates a number of topics of interest. Specific attention was to be given to collecting data concerning: 1) existing locust/grasshopper population models, 2) crop

loss estimates, 3) farming practices and costs of production for millet, sorghum and maize, 4) input and product prices,5) meteorological data (precipitation, degree-days), 6) pest control measures and costs, 7) secondary impacts of control practices on non-target populations and their external effects, and 8) environmental impact studies. Much of this information is already available from the Famine Early Warning System (FEWS) project. Specifically, items 3,4,5 and 8 are already available within the AID Missions; item 1, (existing locust/grasshopper population models), is also already known to USAID entomologists and is comprised of the PRIFAS model and the closely related UNDP model for Senegalese grasshopper. And, item 7 data, (secondary impacts of control practices on non-target populations and their external effects), does not exist. Eliminating the unnecessary and impossible leaves only items 2 and 6, crop loss estimates and pest control measures and costs. These are the items that OSU should have focused on.

In addition to the overly-ambitious SOW, the timing of the contract--and last minute changes in the contract--put the contractor in a difficult position. Specifically, funding for the project was approved only by September 30, 1987. According to the contractor, they had only five days notice that a team was to be in Chad, and that crop loss assessment (i.e., primary data acquisition) was expected of them.

In the SOW for the IPPC, three countries--Gambia, Chad, and Sudan--were identified as "field laboratories." The IPPC team visited one instead of three countries, spending a total of 10 days in the field. Further, the team was smaller than stipulated, with two instead of three members (Albert Fischer trip report). Moreover, the team arrived in Chad without sufficient notification. In consequence, the team had to remain in the capital city for over two weeks at the request of the regional security officer. The Regional Security Officer advised them to stay put until they had official travel orders because Libya had bombed the region only two weeks before. Clearly the team was unprepared for the situation it would face in Chad.

It is unclear why IPPC did not follow through with their contractual agreement to work in Gambia and Sudan. It is also unclear how the additional estimated $35,000 budgeted, but not spent, for field work was spent. Eighteen months later, no report has yet to be received from IPPC by USAID Chad, although reports were produced by Fischer and Murphy.

The IPPC followed the recommendation in the original SOW to use an existing crop-loss methodology (Dively, 1985). Although the Dively method was appropriate and well-adapted to use in Africa, the sample size taken per field (4 hills per field) was so small that no meaningful estimate of losses resulted from the study. Similarly, only 10 fields were examined. Even though the IPPC contract team did not see primary data acquisition as their responsibility, such a meager effort is hardly acceptable.

The IPPC put its greatest effort behind an elaborate economic/biological model couched within the framework of an "expert system". An expert system is simply computer-user interface software that attempts to make the capabilities of a computer model accessible

to an unsophisticated user. However, the end product is only as good as the underlying data and the underlying model structure. If the required data are unreliable, so will be the model. These data include the following, [the status of these data is discussed in brackets]:

1. Output from the PRIFAS Senegalese grasshopper model, which is built into the IPPC model; [modeling experts (outside of PRIFAS) agree that the structure and biological details of the PRIFAS model are highly questionable (Section III-E)].

2. Additional precipitation and potential evapotranspiration data; [few data points per country, could possibly use meteosat CCD data (Section III-E)].

3. Grasshopper sample data as collected during the crop season; [very spotty and of variable quality].

4. Insecticide cost estimates, and risk ratings for birds, mammals, natural enemies, human health, and secondary pest outbreaks; [reliable data can be found on all but secondary outbreak risk].

5. Average yields, areas cultivated for millet and sorghum, and cultivar percentages for each region; [average yield data are misleading due to high variance].

6. Default estimates for when grasshopper sample records are missing data, and which include insecticides used, cultivars attacked, and percent control obtained; [unknown].

In short, much of the data required to run this model are either extremely spotty, unobtainable, or unreliable. On the positive side, the data needs for the model will at least focus attention on the types of data needed in the future.

The second criticism of the model is that it is based on average estimates: average rainfall, average yield, and average consumption by the grasshopper. However, unlike temperate zone rangeland conditions from which this approach seems to be based, subsaharan climate and agronomic factors are enormously variable, and average estimate errors, when compounded within a model, may be highly misleading.

To rectify this situation, AELGA should finance research/training efforts aimed at gathering the critical primary data necessary for cost-benefit calculations. USAID Missions express keen interest in doing crop loss assessment for several reasons. First, crop-loss methods are straight forward and inexpensive. The Dively method can be employed by an experienced researcher who works with Mission and/or Peace Corps entomologists and the host-country research personnel. Second, the research can be

viewed as a training effort, as well as data gathering. The expected output is of course the establishment of several teams of host-country nationals capable of continuing in the future. The researcher should involve HCNs at each and every stage. The analysis of the data and the write-up of reports should be a group activity. Third, crop loss assessment results, along with cost estimates of aerial and ground treatment programs, can be integrated within the FEWS program of each USAID. The FEWS program within each country may be in the best position to integrate these data and to come up with a realistic economic interpretation.

Secondly, AELGA should give serious consideration to an effective mechanism for designing, soliciting and reviewing research proposals. The initial proposal was poor and lead to the creation of an overly-complex output, just as happened with the Dynamac studies. A peer review system and much closer project supervision of the research activities are therefore imperative.

Finally, again, host-country research organizations must be involved in the planning, execution and analysis of this type of research, if these errors are to be avoided. Again, it should be considered equally to be a training exercise.

6. How can current programs be modified to include viable IPM options, and what research and development is needed to further advance this evolvement?

"Current programs" can be modified to include viable IPM options if project managers are made aware of what an IPM strategy is, and encouraged to redirect their project's activities along appropriate guidelines.

An integrated pest management approach seeks a graduated response suitable to control a threat, thus minimizing negative impacts of insect control by:

i) seeking to substitute information for chemicals. Forecasting and ground-survey are the most cost-effective and environmentally sound approach to monitoring conditions in order to treat developing swarms **before** they get out of hand (Section III-E);

ii) using "bio-rational" alternatives to chemicals, when available (Section III-D);

iii) when necessary, using short-duration chemicals with low mammalian toxicity and low toxicity to fish, birds and beneficial insects (Section III-C);

iv) targeting these chemicals with pinpoint accuracy on clearly identified pest concentrations that exceed clearly defined thresholds (Section III-B); and,

v) making sure these chemicals are properly stored, the equipment properly maintained, and outdated quantities and empty containers properly disposed of (Section II).

7. How will this approach reduce or mitigate human, livestock and environmental concerns, (such as storage, disposal, critical environmental areas, endangered species, ground and surface water)?

An IPM approach would reduce or mitigate the adverse affects of pesticide use by:

i) reducing the likelihood that major outbreaks and plagues will occur in the future through forecasting, ground-survey, and strategic intervention early in the outbreak cycle,

ii) seeking highly specific alternative pesticides, such as insect pathogens, which would reduce the dependence on broad-spectrum insecticides to a minimum,

iii) using chemical pesticides with short duration and low non-target toxicity,

iv) applying these chemicals with pinpoint accuracy on clearly identified pest concentrations that exceed established thresholds, and establishing insecticide-free buffer zones surrounding fragile habitats. This would minimize the amount of insecticide impacting humans, non-target organisms, aquatic systems and other fragile habitats,

v) establishing an efficient and flexible response for the purchase and positioning of pesticides, (i.e., pesticide bank), and assuring adequate storage facilities, the safe and clean destruction of old containers and unwanted pesticides. This would reduce the amount, and increase the security, of pesticides actually stored in African countries.