AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

1. TRANSACTION CODE: A (A = Add, C = Change, D = Delete) — Amendment Number: — DOCUMENT CODE: 3

COUNTRY/ENTITY: SUDAN

3. PROJECT NUMBER: 650-0087

4. BUREAU/OFFICE: AFRICA / 06

5. PROJECT TITLE (maximum 40 characters): Medium Term Locust Control

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 02 DD 28 YY 91

7. ESTIMATED DATE OF OBLIGATION (Under "B." below, enter 1, 2, 3, or 4): A. Initial FY 88 B. Quarter 4 C. Final FY 91

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY B. FX	FIRST FY C. L/C	FIRST FY D. Total	LIFE OF PROJECT E. FX	LIFE OF PROJECT F. L/C	LIFE OF PROJECT G. Total
AID Appropriated Total	2,000	0	2,000	2,000	0	2,000
(Grant)	(2,000)	(0)	(2,000)	(2,000)	(0)	(2,000)
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country	0	4,246.7	4,246.7	0	11,088.8	11,088.8
Other Donor(s)	7,592	2,238.6	9,830.6	7,592	2,238.6	9,830.6
TOTALS	9,592	6,485.3	16,077.3	9,592	13,327.4	22,219.4

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	C. PRIMARY TECH. CODE 2. Loan	D. OBLIGATIONS TO DATE 1. Grant	D. OBLIGATIONS TO DATE 2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	E. AMOUNT APPROVED THIS ACTION 2. Loan	F. LIFE OF PROJECT 1. Grant	F. LIFE OF PROJECT 2. Loan
(1) DFA	284	010		-0-	-0-	2,000	-0-	2,000	-0-
(2)									
(3)									
(4)									
TOTALS				-0-	-0-	2,000	-0-	2,000	-0-

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each): 790 930

11. SECONDARY PURPOSE CODE:

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)

A. Code							
B. Amount							

13. PROJECT PURPOSE (maximum 480 characters)

1. To strengthen the capabilities of the GOS Plant Protection Department (PPD) to predict and control locust and grasshoper outbreaks.
2. To develop a structure within PPD for the safe handling, storage and use of pesticides.

14. SCHEDULED EVALUATIONS: Interim MM 10 YY 89 — Final MM 08 YY 91

15. SOURCE/ORIGIN OF GOODS AND SERVICES: ☐ 000 ☒ 941 ☐ Local ☒ Other (Specify) 899.935

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a ____ page PP Amendment)

I concur in the methods of implementation and the financial arrangements under this project.

Linda J. Martin

Linda Martin, Controller

17. APPROVED BY — Signature: Frederick G. Gilbert — Title: Acting Mission Director — Date Signed: MM 10 DD 19 YY 88

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION: MM DD YY

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DOC.#3365G

1. Project Rationale and Description

1.1. Project Rationale

AID, along with other donors and the UN Food and Agricultural Organization (FAO) have long recognized the importance of combatting locust infestation in Sudan. Central and northern Sudan are principal breeding grounds for the desert locust. During periods of major infestation, swarms can and do migrate to neighboring African countries and have been known to reach outside the continent to such countries as Saudi Arabia. Within Sudan, crop damage by locusts has been severe, and a major infestation is in progress at this time. Thus, the rationale for multi-donor assistance is twofold: to reduce crop damage within the country, and reduce the spread of locusts outside the country.

Recent donor participation in locust control in the Sudan has been in the form of emergency campaign assistance. In 1986 the Government of Sudan (GOS), made an international plea for assistance to control a potentially devastating locust invasion. At that time the Plant Protection Department (PPD) of the Ministry of Agriculture and Natural Resources (MOANR) was unable to mount an effective control campaign due to the lack of adequate resources (i.e. pesticides and application equipment, vehicles, and spray aircraft), trained personnel and good field to headquarters communications. The Desert Locust Control Organization for East Africa (DLCO/EA), of which Sudan is a member, equally was unable to assist due to inadequate resources and logistical bottlenecks.

The donors, primarily AID, the Netherlands Government and the EEC, joined resources to mount a multi-donor emergency locust control campaign. Specifically, AID provided assistance to the multi-donor campaign through a grant from its Office of Foreign Disaster Assistance (OFDA) to the EEC which managed a pool of donor funds and expedited emergency procurement of pesticides equipment, and supplies. Other donors provided grants directly to the UN Food and Agricultural Organization (FAO) which provided technical and logistical support to PPD, or provided commodities directly to the GOS.

A Locust Control Steering Committee was formed in 1986 to coordinate donor assistance to PPD. This Steering Committee includes representation from such donors as USAID, the Government of the Netherlands, the European Economic Community (EEC), Canada, the United Kingdom and others, as well as the FAO and the GOS Ministry of Agriculture's Plant Protection Department (PPD). The Steering Committee, chaired by the Government of the Netherlands, has proved a remarkably efficient consultative and coordinating body and continues to meet regularly.

The emergency effort was successful in that (a) equipment and sufficient amounts of pesticides were delivered expeditiously to Sudan, and were distributed efficiently to field stations in time to undertake the required control measures, and (b) continuous monitoring by FAO consultants and the campaign Steering Committee, chaired by the Charge' d'Affaires of the Netherlands Embassy, ensured that PPD continued to receive the necessary technical and administrative support to implement the program.

Various assessments conducted during the emergency campaigns in 1986 and 1987 revealed that the efforts of PPD were continually hampered by unsafe pesticide handling and storage, inappropriate pesticide application practices, poor accountability in the distribution and movement of pesticides and substantial stocks of outdated pesticides in PPD stores. Pesticides often are hazardly stored, with substantial container seepage on the ground. PPD pesticide stores are in poor structural condition and are placed nearby residential areas, creating serious threats to health and safety of residents and workers. The pesticide situation is exacerbated by the irrigated agricultural sector which imports large quantities of cotton pesticides each year, and passes on all old, outdated, and excess stocks to PPD. PPD is not in a position to refuse any of these donations, as they receive very little in the way of pesticides, being reliant on the severely strained GOS annual budget and donor contributions. As a result, PPD stores are often crammed full of old cotton pesticides.

AID and other donors became concerned that the series of emergency assistance programs, while providing valuable and needed responses to major locust plagues, did little to encourage or assist the GOS in improving its own institutional capabilities with a view to becoming less dependent on outside support. The GOS will continue to be heavily dependent on external assistance in times of major outbreaks, especially for the foreign exchange costs of eradication programs. However, it was felt that much could be done to strengthen the government's capacity to assume a greater role in locust control activities and to improve its operations.

The donors agreed that a study was needed to determine precisely the elements of a future multi-donor project to address PPD's institutional and operational weaknesses. To achieve this goal, donors financed a study in February 1987 which identifies four principal requirements. These are:

1. The need to reorganize and strengthen the locust control function within the PPD in order to make it a semi-autonomous unit which could expand rapidly in times of major infestation.

2. The need to provide training to PPD in order to improve inventory control of pesticides.

3. The need to provide training to PPD staff in safe handling of pesticides.

4. The need to provide for safe disposal of outdated pesticides now in the PPD inventory.

A draft project document, outlining a plan for specific activities for each of the requirements, was developed by a multi donor team in October/November 1987. Based on this draft project document, FAO developed a Plan of Operation for assistance to PPD. This has been reviewed and accepted by the donors.

A PID embracing these elements and contemplating a multi-donor project was approved by USAID and sent forward for review by AID/W in January 1988. ECPR guidance was received in April 1988. That guidance approved the project concept, including the proposed pesticide disposal activity. However, ECPR requested that the pesticide disposal activity be the subject of a separate study and be based on a careful and controlled experiment to determine the optimum disposal method consistent with environmental safety. Therefore, the project contemplated herein does not contain the pesticide disposal element. A separate design team is scheduled to begin work in 1989 to design the pesticide disposal phase of this project.

1.1.2. Conformity with Recipient Country Strategy and Programs

The Sudan Multi-Donor Medium Term Locust Control Project will assist the GOS to combat locust and grasshopper outbreaks and invasions. The project is in consonance with the GOS priorities for agricultural development and food security. These priorities include crop protection, one of the bases for increasing agricultural production.

Sudan is a preferred breeding area for the desert locust, which has a potential invasion area extending as far west as Mauritania, east into India and Pakistan, north to southern Europe, and south to Central Africa. Desert locust infestations pose a serious threat of crop devastation and create the potential for famine conditions. The GOS' priorities are an indication that in Sudan, as well as in the East African region, positive developments in agricultural production can only be sustained if the locust threat is controlled.

1.1.3. Relationship to AID Strategy

i. USAID/Sudan Country Strategy. The proposed multi-donor project supports USAID's strategy to increase agricultural production and marketing and improve food security through averting or reducing crop losses and the opportunities for plague and famine.

ii. Africa Bureau Locust/Grasshopper Strategy. The proposed project activities are within the framework delineated in the Africa Bureau Locust/Grasshopper Strategy Paper for non-emergency pest control programs. This strategy places a high priority on the control of locust and grasshopper infestations, which annually result in significant crop losses and periodically lead to plague and famine. In conformance with the Strategy, the proposed project builds on the experience and knowledge gained in the 1986 and 1987 multi-donor emergency locust control programs, and emphasizes the development and strengthening of techniques in surveillance, detection, pest control strategies, pesticide handling and the training of host country personnel.

iii. Other Donor Activity. As a multi-donor effort, the project draws on the financial resources, expertise and experience of various donors in locust control under the technical guidance of the FAO Directorate for Emergency Locust Control Operations. In its effort to contain and reduce the effect of locust outbreaks, the FAO advocates plague prevention for three major African locust species (desert locust, African migratory locust, and tree locust), and

places high priority on the strengthening of national locust units, regional cooperation, and international donor support and coordination. All the major donors supporting the Locust Control Project, AID, the Royal Netherlands Government, European Economic Community (EEC), the Overseas Development Administration (ODA) of the United Kingdom, and Canada, are fully supportive of the FAO strategy.

In the area of pesticide management, the World Bank, under the Agriculture Rehabilitation Project, plans to augment the Medium Term Locust Control Project activities by initiating a pesticide disposal program on the irrigated schemes. The Bank's proposal includes an assessment of outdated chemicals, destruction of old chemicals by means successfully demonstrated by the medium term locust project and the institution of better pesticide management procedures.

1.1.4. Beneficiaries

Benefits to the project will accrue to a large number of Sudanese. Once functioning the benefits of the project are expected to spread to other countries in the region that are affected by outbreaks of desert locusts. Primary beneficiaries will be the Plant Protection Department of the Ministry of Agriculture and Natural Resources. Project resources will go directly to strengthening this organization's ability to systematically implement locust eradication campaigns. Locust control workers will benefit from decreased health risks due to the safe use of pesticides. Significant benefits also will accrue to the agricultural sector, in terms of increased yields, and to the consumer in rural and urban areas in terms of increased supply of food. Other beneficiaries will be those countries who will benefit from decreased locust infestations as a result of improved PPD efficiency.

1.2. Project Description

The Sudan Multi-donor Medium Term Locust Control Project consists of four components: 1) Core Project, which will assist the GOS in establishing a functioning Locust Control Unit, 2) Pesticide Disposal, 3) Rehabilitation of Pesticide Stores, and 4) Improvement of Pesticide Stock Control Procedures.

The multi-donor "Core Project", including AID assistance, will be implemented through the Directorate for Emergency Locust Control Operations (DELCO) FAO Rome. The core project will be sustained by a pool of funds supplied by AID, the Netherlands, the EEC and possibly other donors and managed by FAO, and through other bilateral donor support directly to the GOS. AID will make an additional contribution of funds which will be held separately from the multi-donor pool and will finance activities of special interest to AID, such as research, evaluations, monitoring and related equipment. The multi-donor pool of funds will finance technical assistance, training, commodity procurement, and other related costs. The ODA and Canada will undertake bilateral agreement activities with the GOS in support of the "Core Project". AID, through a bilateral grant from its Office of Foreign Disaster Assistance with FAO and the German Agency for Technical

Cooperation (GTZ) through an agreement with the Desert Locust Control organization are supporting two core project technical advisers.

The Pesticide Disposal Component will be funded entirely by USAID and GOS, and will be accomplished either through a bilateral agreement or through an agreement among USAID, FAO and GOS. The final decision on this is dependent on the findings and recommendations of the Pesticide Disposal Design Team, which is scheduled for a later date. The remaining two components, Rehabilitation of Pesticide Stores and Stock Control Procedures will be implemented through direct bilateral agreements between the Government of the Netherlands and the GOS. Thus, USAID's direct implementation will be limited to monitoring, evaluation and coordination through the Steering Committee with FAO and parallel donors.

Nearly all of USAID's core locust component assistance will be provided through a grant to FAO. As mentioned previously, a portion of these funds will be held separately from the multi-donor pool. The FAO is well equipped and experienced in locust control activities throughout Africa. USAID has a long-standing and successful relationship with this international organization. The base documents which will govern the core project implementation will be the FAO Plan of Operation, dated June 1988, and the grant agreement to be entered into between USAID and FAO. The FAO document has been accepted by all donors. Thus, the need for USAID's direct involvement will not be substantial and will be principally limited to continued active participation on the Steering Committee. FAO will be the primary implementing agency representing the donors, while the Government of Sudan's primary agent will be the Ministry of Agriculture and Natural Resources, Plant Protection Department, and Locust Control Unit. The Ministry has signed a letter confirming that the Locust Control Unit has been established as an independent entity within the PPD (see Annex B).

1.2.1. Project Goal

The goal of the Medium Term Locust Control Project is to contribute to increased food availability by establishing the institutional capacity for GOS to effectively implement locust and grasshopper control activities, and to maintain safe handling, storage and use of pesticides.

1.2.2. Project Purpose

The Medium Term Locust Project has dual purposes:

a. to strengthen PPD's capabilities to predict and control locust and grasshopper outbreaks, and

b. to develop a structure within PPD for safe handling, storage and use of pesticides.

Conditions that will exist at the end of the project are as follows:

- PPD will be implementing improved recession survey for desert locust, especially during summer.

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- PPD will be organized to mount quickly a large locust campaign at short notice, using ULV method.
- PPD will be utilizing improved labor intensive ground control operations in times of upsurge.
- PPD will be utilizing a reduced quantity of liquid pesticides used in locust control through better application methods.
- PPD will be effecting a reduction in cost of locust control due to the use of appropriate pesticides and application rates.
- PPD will be implementing a cost-effective grasshopper control system.
- Pesticides application health risk will be reduced to operators and bystanders.
- PPD staff will be correctly handling and storing pesticides according to acceptable safety and health standards.
- PPD will be implementing a locust control program at acceptable minimum stock levels.
- PPD will be maintaining safely located and constructed pesticide stores.

1.2.3. Project Elements

1. Establishment of a Core Locust Unit

Under this component of the Project, FAO will assist the PPD with the following activities:

a. Establishment of a Locust Control Unit within the Locust and Grasshopper Section of PPD. The Unit will be responsible for:

i. locust survey, especially in times of recession;
ii minor control in times of recession and incipient upsurge;
iii organization, direction and implementation of control campaigns in case of failure to contain upsurge within the country and in case of invasions from elsewhere.

b. Establishment within the Unit of five regional bases and a headquarters in Khartoum (regional bases to be located at Kassala, Ed Damer, El Obeid, El Fasher, Khartoum).

c. Development within the Unit of an improved information service, including improved information transfer and analysis.

d. Development of a high level of skill among Unit staff, especially in survey, in the direction of aerial spraying and in ULV ground control.

e. Determination of the best pesticides for ULV control.

f. Production of a "Manual" for Unit field staff and seconded officers.

g. Creation of a pool of trained officers from outside the Unit (other PPD branches) who can be seconded to LCU for major campaign activities.

h. General adoption of sound safety procedures, including the use of protective clothing when loading and applying pesticides.

i. Establishment of threshold control levels for grasshopper control.

a. Establishment of a Core Locust Control Unit

The LCU has been established, as an autonomous unit within the Locust and Grasshopper Section of PPD in Khartoum. The Head of the Unit will be directly responsible to the head of the Locust and Grasshopper Section, who in term is responsible to the Director of PPD. All other LCU staff will come under the direction of the appropriate person within the Unit as indicated on accompanying Figure 1. Staff for the LCU will be provided by the redeployment of present staff within the PPD. This will not be difficult since locust control is currently PPD's dominant activity. Indeed, the creation of the LCU should release manpower resources to devote to normal crop protection work.

b. Establishment of Regional Units

The core project activities will take place at the Headquarter of PPD in Khartoum and at the five regional offices located at El Fasher, Kassala, El Obeid, Ed Damer and Khartoum in the summer breeding (June-December) areas. Staff from these regional offices will be seconded to the Red Sea Coastal area from December to May to survey and control locust during the winter breeding period. The regional centers will serve as base stations for monitoring, reporting and control of locust activity. It is obviously not possible to predict the location of actual field activity relating to locust control, as these are dependent on the severity and locations of infestations.

c. Improved Information Service

The core project will assist LCU to improve and augment current locust information collection, analysis, forecasting, and reporting. The following is a description of information activities which will constitute LCU's regular information service.

Locust information arriving at headquarters will be plotted each day and analyzed in relation to current weather. Weather information will be obtained by a daily visit to the forecasting office of the Meteorological Department at Khartoum airport.

Information for the situation outside Sudan will be derived mainly from FAO, either through the Monthly Bulletin or through special telexed warnings. The analysis will take account of the results of any aerial surveys and possibly some remote sensing products. The Information Officer will keep records of staff location and movements, aviation, gasoline and diesel fuel availability and pesticide location and usage. The Information Officer will discuss the situation with the Head of the Unit, or if he is absent, the

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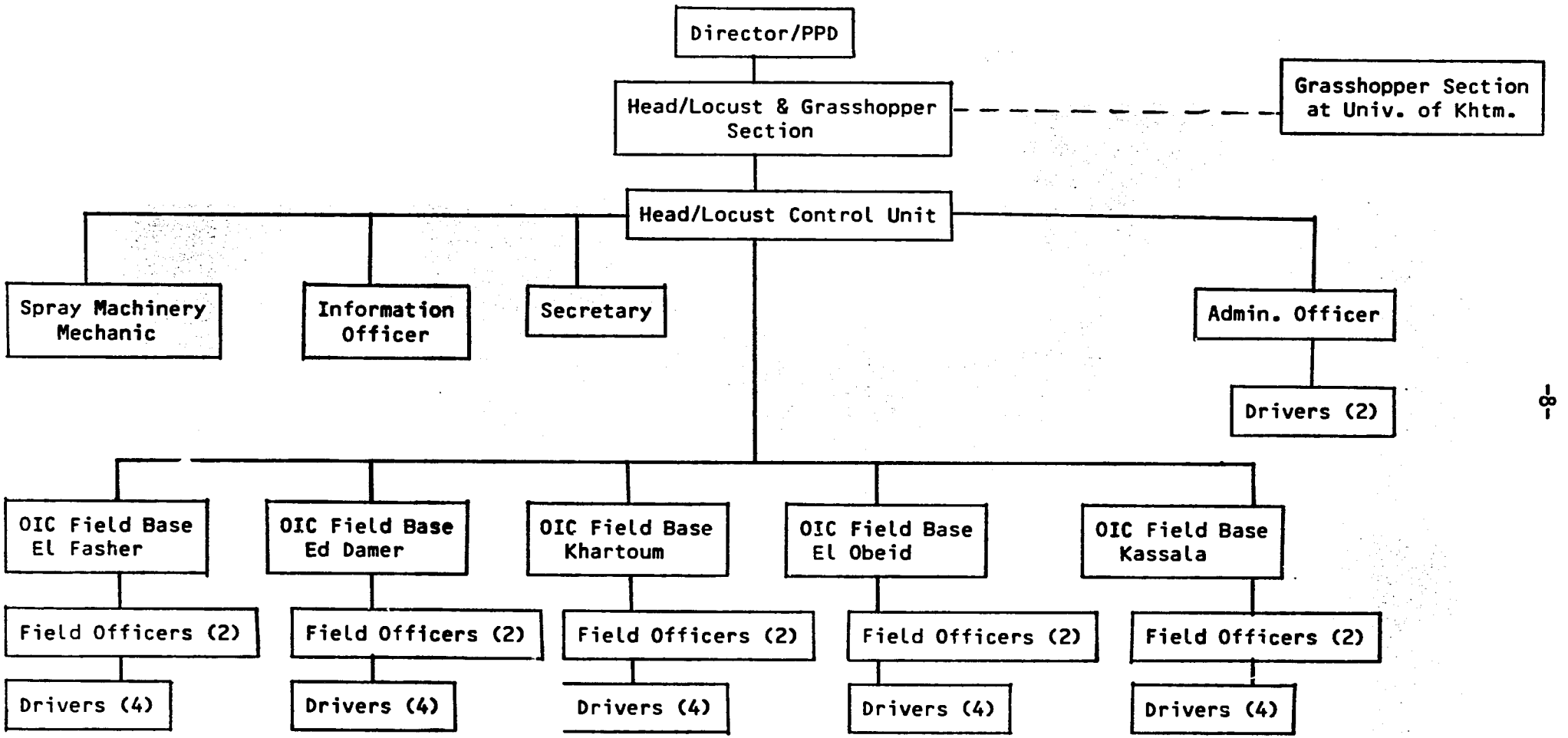
FIGURE 1

LOCUST CONTROL UNIT

ORGANIZATIONAL CHART



Total Unit Personnel: 42

Dotted line indicates reporting, liaison, coordination function

Senior Field Officer daily. The senior officer of the Unit present in Khartoum will inform the Head of the Locust and Grasshopper Section of any significant development.

If control is in progress the Information Officer will keep records of control activity, including aircraft and spray monitoring locations.

The officer-in-charge (OIC) of a base will be responsible for most field surveys in his sector and for sections of a large campaign. He will also be responsible for equipment assigned to his base, including vehicles.

Assistance in the improvement of the information and forecasting service primarily functioning of regular radio contact between Khartoum and the field and the use of weather information will be provided by an Information and Forecasting Advisor. This person is currently on assignment to FAO for thirty-six months and has been attached to the LCU. This advisor has been funded by AID through the Office of Foreign Disaster Assistance.

d. Development of Survey Skills

The Head of the Locust Control Unit will be responsible for all aspects of the unit's operation and will himself take charge of the operation of all major control campaigns. The Head of the LCU will be responsible for the standards of survey and control.

The officer-in-charge (OIC) of each base will be responsible for most field surveys in his sector and for sections of large campaigns. The OIC will also be responsible for equipment assigned to his base.

Survey methods will concentrate on simple methods of population estimation, mainly foot transect counts for non-swarming populations, and reporting of sizes of gregarious infestations. Biological information will be restricted to stage of insect development and behaviour. Information will be recorded on reporting forms in the field, an important source of information will be local people, especially pastoralists. The emphasis will be on the rapid transfer of accurate information by radio to the Information Officer in Khartoum. The date and location of sighting, and the route followed during survey are both essential. These tasks will be carried out primarily by officers assigned to the field bases.

As pointed out in the social analysis the greatest impact of control activities is likely to be in the pastoral sector. To alleviate effects on the pastoral sector, the LCU will fund a study through an appropriate local institution that will determine major transhumant routes in concerned areas.

Aircraft supply will be authorized by the Head of the Locust and Grasshopper Section, but deployment will be determined by the head of the Locust Control Unit. Secondment of other officers and vehicles from other PPD divisions will be carried out on the authority of the Director of PPD upon the declaration of an emergency locust situation by the Ministry of Agriculture.

Approximately one ton of the appropriate formulation of promising ULV pesticides will be obtained and field tested as opportunity occurs. The tests are likely to take the form of well monitored ground application carried out under operational conditions.

Prototype sprayers now available will be field tested, especially for robustness and ease of operation. A progressive attempt will be made to standardize ULV spray machinery for locust and grasshopper control. ULV control operations need to take into account:

1. weather conditions, especially wind;
2. the type of target; and
3. the size of target in relation to swath width.

Officers carrying out or directing spray operations also must understand the way in which the speed of the aircraft, vehicle or man on foot, the emission rate and the track spacing determines the optional area dosage. The proper methods will be covered in training courses, and reinforced by on-the-job training.

Records of pesticide for locust control and equipment assigned to the locust unit, both quantity and location, will be maintained by the unit's Administrative Officer. The record of pesticides issued will be the responsibility of the Regional Pesticide Stores Officer, but the unit officer at the appropriate base will make regular physical checks of the stock of locust pesticide held. The Administrative Officer will make at least an annual tour to carry out a physical check of all Unit stores and equipment.

LCU will be assisted in the development of standards and control by an Applications and Control Advisor supplied to the Unit through DLCO/EA. This advisor is funded by GTZ and will be made available to the LCU for thirty-six months. FAO will provide additional short-term assistance to LCU in survey and field operations.

e. Determination of Best Pesticides

FAO will assist the LCU in determining the best pesticide for ULV control. This will fall under the responsibilities of the Applications and Control Advisor. As part of its functions FAO will organize a technical team to investigate the feasibility of establishing an off-shore pesticide bank. If feasible FAO and LCU will approach donors on implementing the bank.

f. Production of Manual for Field Staff

Assisting the LCU in the production of the manual of operation will be the responsibility of the Chief FAO technical advisor. The CTA will ensure the input of the other technical experts in the manual and assume full responsibility for the organization and writing of the manual.

g. Creation of a Pool of Trained Officers

In consultation with the head of the Grasshopper and Locust Section, the head of the LCU, and the FAO Chief Technical Advisor (CTA), the Director of PPD will identify 30-40 PPD officers from various PPD departments for potential secondment to LCU during locust emergencies. This pool of officers will receive new skills or upgraded training in locust survey and control techniques, ULV techniques and applications, and the safe use and handling of pesticides. The CTA will be responsible for the training of this pool of personnel through arranging staff secondment for one full season to the LCU, providing formal short courses and possibly overseas observational visits.

Particular attention will be paid to instruction in and implementation of sound safety procedures in handling and application of pesticide by Unit staff and seconded officers. Safety will be a major feature of all training courses. It will be the responsibility of every officer to see that those under him behave in a sensible way. The Head of Unit, through the Administrative Officer, will ensure that the necessary equipment and clothing is available.

h. Grasshopper Threshold Final Study

It is well known that grasshoppers cause damage to crops in Sudan, but it is not known at what level of infestation it becomes economically advantageous to initiate control measures. Therefore, a grasshopper threshold study is incorporated into this project. The threshold study will evaluate available control alternatives and their efficacy in relation to grasshopper populations and crop yield. Assuming it is discovered that control produces long lasting protection and a significant increase in yield, it then becomes important to develop appropriate control methods. The cost of these, set against the value of the crop saved will allow threshold levels to be set. Due to the need for food production, these may be set lower than a simple cost/benefit ratio would suggest.

2. Core Project Inputs

The core locust project will be implemented by the Plant Protection Department with technical, administrative, and logistical support from the Directorate for Emergency Locust Control Operations (ELCO) of FAO/Rome. FAO/Rome has substantial experience in organizing locust control campaigns and has a worldwide mandate for coordinating and support locust control programs.

The FAO Representative's Office in Khartoum will provide administrative and logistical support for the project.

The following resources will be made available to the LCU and PPD, either by FAO, drawing on pool of multi-donor funds, or by individual donors under parallel funding arrangements.

a. Technical Assistance

A six-person long-term technical assistance team and various short term technical advisers are provided through the core project, either financed by the multi-donor pool of funds or by parallel donor contributions. The advisers will work under the technical guidance of the Directorate for ELCO, FAO/Rome and will assist the LCU in all aspects of locust survey and control. The specific scopes of work for all advisers are contained in Annex J.

The long-term technical assistance advisers and their source of funding are as follows:

- Chief Technical Adviser (financed by multi-donor fund).
- National Coordinator (financed by AID local currency trust fund).
- Grasshopper Expert (financed by AID local currency trust fund).
- Application and Control Expert (financed through agreement between GTZ AND DLCO/EA).
- FAO Locust Information and Forecasting Expert (financed by AID through bilateral agreement between its Office of Foreign Disaster Assistance and FAO/Rome).
- Management and Logistics Expert (financed by AID local currency Trust Fund).

The multi-donor fund will also finance a total of 19 person-months of short-term technical assistance in survey and field operations, spraying equipment operations and calibration and project monitoring and evaluation.

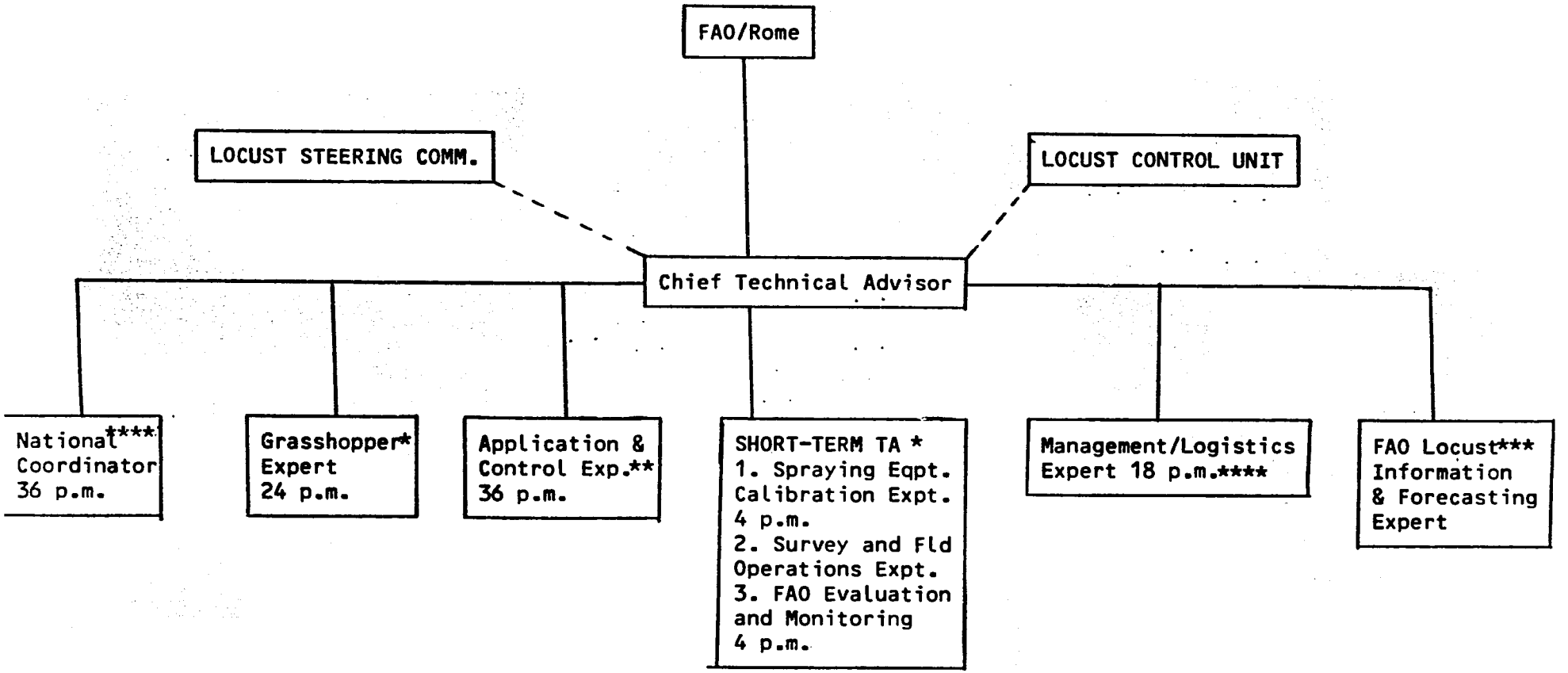
The Chief Technical Adviser (CTA) will be responsible for the supervision of the core component advisors, the scheduling of short-term technical assistance, disbursements under the project and FAO project administration. The advisor also will organize and participate in training and assist in the preparation and implementation of the other components of the project. The organization and editing of the locust "Manual" also will be CTA's responsibility. CTA will report directly to FAO/Rome and will advise the Head of the Locust Control Unit and the Steering Committee on all aspects of the project. The technical assistance attached to the FAO is graphically presented in Figure 2.

b. Training

Proper training in both technical and safety aspects is vital to the success of a project of this type. The majority of the training for the Core Locust component will be done by the FAO staff, charged with overall component operations. It has been recommended in the Environmental Analysis (EA) that sources independent from the core locust component provide assistance and additional training. These are detailed in Environmental Analysis Summary in Section 5.5. An illustrative timeframe for the training can be found in the Implementation Table.

FIGURE 2

ORGANIZATION OF FAO TECHNICAL ASSISTANCE TEAM



N.B. The FAO Locust Information and Forecasting Expert and Application and Control Expert is not charged to the project. Dotted lines indicate reporting, liaison and coordination functions

* Financed by the core project.
** Financed by GTZ (German Agency for Technical Cooperation) through agreement with DLCO/EA.
*** Financed by AID Office of Foreign Disaster Assistance through grant to FAO.
**** Financed by AID Local currency Trust Fund.

Overseas training for the senior staff of the Locust Control Unit will be arranged by FAO. FAO will arrange logistical support and ensure overseas trainees have adequate health insurance. Training will consist of the following: the Head of the Unit will visit Saudi Arabia and observe the functional operation of Saudi Arabia locust control organization. The officers in charge of the field bases and the Information Officer will travel to and participate in a functional locust control unit, for example, the Australian Plague Locust Commission. The Information Officer also will visit FAO/Rome. The Equipment officer will visit ULV spray machinery manufacturers to be instructed in maintenance and repairs.

In-country technical training will be done by the FAO staff, primarily the Chief Technical Adviser and the Application and Control Expert. This will consist of formal short courses for the field officers, particularly in the techniques and principles of ULV application and the safe use and handling of insecticides. An independent pesticide expert, as recommended in the Environmental Assessment (EA), will assist in the safe use and handling aspect. Short courses will also be given for 18 regional entomologists within PPD, in particular to explain their role and responsibilities, and also the basic elements of locust survey and control. A third series of short courses will be used to train selected PPD technicians to facilitate a pool of field officers to be drawn on in times of emergency. A small number of officers from this group should be seconded to the Core Locust Unit for a season to gain practical experience.

On-the-job training for support staff will be conducted at the regional bases and in the field. FAO staff, LCU officers and a consultant, as outlined in the EA will be responsible for coordinating and conducting this training. Areas of emphasis will include proper loading and unloading of containers, proper transfer of insecticides from containers to spray equipment, proper clean-up of insecticide spills, proper operating, maintenance and clean-up of equipment, proper use of safety equipment and clothing, and proper storage of empty containers.

Of prime importance is the health of the people involved in the project. To ensure this, provisions have been made in the EA for a health specialist to conduct a training program for selected PPD technicians in the use of the Lovibond Test Kit. The health specialist will advise PPD on the development and implementation of a program for the protection of workers at high risk due to high body burdens of cholinesterase-inhibiting pesticides, based on the data collected using the Lovibond kits. The detailed scope of work is located in Annex H.

c. Commodities

The vast majority of commodities to be supplied under the multi-donor core project will consist of approximately 1,400 metric tons of pesticides. In addition, small amount of office equipment for the University of Khartoum, where the grasshopper research portion of the project will be carried out, will be purchased . Other equipment needs will be provided by the Government of Canada. These include camping gear, survey and camping equipment,

communications equipment, protective clothing, and grasshopper threshold estimation equipment. Generally, LCU, PPD and the regional officer have adequate equipment and furnishings. Therefore, large expenditures for these items are not warranted under the core project.

Vehicles will be supplied by ODA directly to the GOS. An initial estimate of vehicle requirements are 21 Landrovers, 10 Landrover Wagons, one truck and spare parts for LCU's locust control activities and related safety field work. The final configuration of vehicles will be determined by ODA and PPD. One vehicle will be provided to the University of Khartoum to carry out threshold level field research. It is anticipated that ODA will provide technical assistance to the PPD for vehicle repair. Vehicles will be assigned to the LCU and to the regional officer.

d. Other Costs

Additional resources will be provided for approximately 600 hours of aircraft time for the purpose of reconnaisance, as well as pesticide spraying. It is also anticipated that resources may be used for remote sensing if current evaluations prove this to be a viable tool for locust infestation predictions.

AID will set aside funds from the multi-donor pool to finance specific activities to satisfy AID environmental and research requirements and AID evaluation criteria. These activities are evaluations, monitoring and special studies such as testing the feasibility of establishing an off-shore pesticide bank and the effect of locust control activities on transhumant routes. These activities will be planned and implemented under AID guidance.

2. Pesticide Disposal

The pesticide disposal component of the MTLC project will be designed as an amendment to this PP and attached EA. The purpose of this component will be to dispose of unwanted and unusable pesticides in the PPD store. Also during the preparation of this amendment, the design team will evaluate the feasibility and alternatives for decontamination of the PPD store sites.

During the fall of 1988, OFDA will conduct and monitor a trial disposal activity at a cement kiln in Atbara. This method is one alternative for the disposal of the pesticides. The design team will evaluate the results of this activity in its preparation of the amendment to the PP. Other alternatives will be considered and analysed, for example, fluidized bed and burial.

In the design process, the team will take into account the entire operation of disposal. From the clean up of the store site, to transportation of the waste material to the disposal site, to the actual disposal process. Feasibility of the design and alternatives of disposal will be a major component of the team activities. The terms of reference for the pesticide disposal design effort is attached as Annex I.

3. Rehabilitation

Through a bilateral agreement between Directorate Generale Voor Internationale Samenwerking (DGIS) and the GOS, the Government of the Netherlands will finance the rehabilitation of 14 PPD pesticides stores and the construction of 15 new stores. Construction activities are planned over approximately three years. The intent of the rehabilitation component is to create safe, properly-located and constructed storage facilities. This should result in reduced health risks to workers and adjacent communities.

A Dutch consulting engineering firm, contracted by the Netherlands Embassy, conducted an assessment of PPD pesticides stores in 1987 and developed a standardized construction and rehabilitation plan. The plan incorporates structural environmental safeguards to ensure acceptable safety and health standards. The Steering Committee has reviewed and approved the plan.

The Netherland's Embassy in Khartoum advertised tenders in June 1988 for local civil contractors to implement construction. Contracts are expected to be let late summer 1988. The Netherland's Government will finance the services of an engineering consultant to assume prime responsibility for materials supply (local and imported), and the organization of works and logistics since general contractors are unavailable in Khartoum. General Logistical support will be provided by the logistics officer hired under the core locust control component. The Netherlands Embassy will hire a consultant as project manager.

The Netherlands Embassy will backstop implementation of rehabilitation activities in close cooperation with PPD and the Steering Committee. The Steering Committee will ensure adequate coordination between the rehabilitation component and the other related medium term project activities. The Ministry of Works will advise the building consultant on GOS regulations and standards and will monitor construction for the GOS. A subcommittee composed of donors and the GOS will be constituted as the operational body, to guide implementation.

4. Pesticides Stores Stock Procedures Improvement

This activity will be implemented through a bilateral agreement between the DGIS of the Netherlands Government and the GOS. This activity will address the inefficient and unsafe stock control practices currently utilized by PPD. Through this component an inventory control system, which incorporates procedures to ensure safe minimum stock levels, safe handling, storage, distribution and accountability for pesticides, will be introduced and incorporated into PPD stores operations. The plan for this activity has been developed by LOGION, VGL, a Dutch logistics and management firm. During the 1987 locust emergency, a LOGION consultant worked with the PPD to facilitate the importation, clearance and distribution of supplies in Sudan.

The LOGION plan proposes the following activities:

i) The organization of a logistical unit, combining the existing transport and logistics sections of PPD and the selection of a logistics manager;

ii) implementation of an appropriate administrative system; and

iii) the training of relevant personnel at PPD field stores and PPD headquarters in logistics (inventories, warehousing and transport).

Under this plan short-term technical assistance will be provided to PPD by a logistics training expert and a logistics implementation expert.

The LOGION plan will be executed under the management of PPD, and guidance of the Project Steering Committee. LOGION will collaborate specifically with the Pesticide Inspection Section of PPD, in addition to the existing logistics divisions, to ensure that safety and proper handling procedures are incorporated in the proposed new logistics system and training.

PAR TONE

2. Cost Estimate and Financial Plan

2.1. Total Project Cost Estimate

The total cost of the Medium Term Locust Control Project, with the exception of the pesticide disposal activity, is $22,919,400 over the three year life of project. This figure represents foreign exchange costs and local currency costs converted at LS 4.5:U.S.$1.

The following table provides a breakdown of total project costs by component and funding category.

TABLE 1
Multi-Donor Medium Term Locust Control Project
Summary of Project Costs
($000 or equivalent)

Project Component	Foreign Exchange	Local Currency	Total
A. Core Locust Control (FAO)	6,092	11,088.8 1/	17,180.8
1. Technical Assistance	1,120		
2. Training	116		
3. Commodities	3,406		
4. Other Costs	1,450		
B. Pesticides Disposal (USAID)	costs to be determined.		
C. Pesticides Stores Rehabilitation (Netherlands) Contract, equipment, supplies	3,200	2,211.2 2/	5,411.2
D. Stores Procedures Improvement (Netherlands)	300	27.4 3/	327.4
1. Technical Assistance	200	-	
2. Training	100	-	
Other Costs	-	27.4	
TOTAL (Minus Pesticides Disposal)	9,592	13,327.4	22,919.4

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1. Includes approximately $3,679,900 equivalent in counterpart funds from GOS owned and USAID/GOS jointly programmed local currency fund ($799,300 equivalent to be made available to FAO from the PPD counterpart account); $126,000 equivalent in Trust Funds to USAID; the remainder represents GOS' contribution in-kind ($7,282,900 equivalent).

2.&3. Total amount funded from Government of Netherlands/GOS local currency fund.

2.2. Costs for Core Locust Control Component

The cost of the core locust control component is $17,180,800. This cost represents both foreign exchange contributions by donors ($6,092,000), the GOS' cash contribution ($3,679,900 in counterpart funds of which $799,300 will be made available to FAO; $126,000 equivalent in Trust Funds to USAID) from the GOS owned and USAID/GOS jointly programmed local currency fund, and GOS contribution in-kind ($7,282,900).

Table 2 provides a general breakdown of foreign exchange (FX) and local currency (LC) obligations by fund source to the core component.

Table 2

Summary Donor and GOS Contribution
to Core Locust Control Component
($000)

Fund Source	FX	LC	Total
AID	2,000	-	2,000.0
NETHERLANDS	940	-	940.0
EEC	1,546	-	1,546.0
ODA	1,436	-	1,436.0
CANADA	170	-	170.0
GOS	-	11,088.8	11,088.8
Total	6,092	11,088.8	17,180.8

Table 3 provides a breakdown of cost estimates for foreign exchange and local currency costs by line item. Table 4 provides a breakdown of local currency costs by source of funding.

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Table 3

Core Locust Control Component
Breakdown Of Cost Estimates
($000 or Equivalent)

	Item		Foreign Exchange	Local Currency	Total
I.	Long-Term Personnel	p/m	958.5	1,632.3	2,590.8
	Chief Technical Advisor	36			
	National Coordinator	36		72.0	
	Grasshopper Expert	24			
	Management & Logistics Expert	21	-	31.5	
	Secretary	36	-	28.8	
	GOS Personnel & Allowance			1,500.0	
II.	Short-Term Personnel	19	161.5	-	161.5
III.	Training		116.0	119.8	235.8
	Fellowship and National Training courses, in-country training		116.0	119.8	
IV.	Commodities		3,406.0	3,572.5	6,978.5
	Pesticides		2,700.0	2,314.5	
	Fuel			896.9	
	Oil			5.6	
	Avgas			355.5	
	Equipment		170.0		
	Vehicles		536.0		
V.	Operational Support			2,608.2	2,608.2
	Housing			667.0	
	Casual Labor			373.4	
	Vehicle/Equipment maintenance			100.0	
	Port Clearing and Handling			622.3	
	Vehicle Hire			350.0	
	Salary Supplements			463.5	
	Official Travel			32.0	
VI.	Construction			755.5	755.5
	Field Camp Construction			533.3	
	Construction of offices (LCU)			222.2	

VII. Other Costs	1,450.0	1,650.5	3,100.5
Aerial Spraying (aircraft hire)	1,250.0	1,400.0	
Flying hours, pilots, engineering, mechanics		17.8	
Efficacy/Safety/Health Monitoring	-	126.0	
Lovibond Cholinesterase Kit and Supplies	17.8		
Evaluations, other Studies	182.2		
Sub-Contract Univ. of Khartoum Grasshopper threshold study)	-	106.7	
Sub-Total	6,092.0	10,338.8	16,430.8
Contingency/Inflation	-	750.0	750.0
TOTAL	6,092.0	11,088.8	17,180.8

Table 4
Core Locust Control Component
Local Currency Financing Plan
($000 Equivalent)

	Item	Joint USAID/GOS Program Counterpart To FAO	Joint USAID/GOS Program Counterpart To PPD	Joint USAID/GOS Program Trust Funds To USAID	GOS In-Kind	Total
I.	Long-Term Personnel	132.3	-	-	1,500	1632.3
II.	Short-Term Personnel	-	-	-	-	-
III.	Training	-	119.8	-	-	119.8
IV.	Commodities	-	278.5	-	3,294.0	3572.5
	Pesticides	-	-	-	2,314.5	
	Fuel	-	272.9	-	624.0	
	Oil	-	5.6	-	-	
	Equipment	-	-	-	-	
	Vehicles	-	-	-	-	
	Avgas	-	-	-	355.5	
V.	Operation Support	667.0	1,563.4	-	377.8	2,608.2
	Housing	667.0				
	Casual Labor		373.4	-		
	Vehicle/Equipment Maintenance		100.0	-		
	Port Clearing & Handling		244.5	-	377.8	
	Vehicle Hire	350.0		-		
	Salary Supplements (field Allowance)		463.5	-		
	Official Travel		32.0	-		
VI.	Construction	-	222.2	-	533.3	755.5
	Field Camp Construction			-	533.3	
	Construction of offices (LCU)	-	222.2			
VII.	Other Costs		124.5	126.0	1,400.0	1,650.5
	Aerial Spraying (aircraft hire)	-		-	1,400	
	Flying hours, pilots, engineers mechanics	-	17.8	-		
	Efficacy/Safety/Health Monitoring		-	126.0	-	
	Lovibond Cholinesterase Kit and Supplies	-	-	-	-	
	Evaluations, other Studies	-	-	-	-	
	Subcontract Univ. of Khartoum (Grasshopper threshold study)	-	106.7	-		
	Sub-Total	799.3	2,308.4	126.0	7,105.1	10,338.8
	Contingency	-	572.2	-	177.8	750.0
	TOTAL	799.3	2,880.6	126.0	7,282.9	11,088.8

2.2.1. AID Contribution

AID's contribution of $2,000,000 may be used for any of the foreign exchange costs as planned in Table 3. In addition, AID will request $126,000 equivalent Sudanese Pounds from GOS owned and USAID/GOS jointly programmed Local currency generations for local expenses for project monitoring (Trust Fund). However, USAID/GOS jointly programmed local currency will not contribute to any construction activities, unless detailed plans and cost estimates are developed.

2.2.2. GOS Contribution

The Government of Sudan's contribution to the Core Locust Control Component is the equivalent of $11,088,800. The GOS' contribution will be made from the GOS owned and USAID/GOS jointly programmed local currency fund ($3,679,900 in counterpart funds of which FAO will receive the equivalent of $799,300 in local currency) and in-kind contribution in the form of salaries, allowances and other operational expenses for locust control.

Trust Funds disbursed to AID will finance local costs for project monitoring, as outlined in Table 4. Counterpart funds to FAO will finance housing for technical assistance personnel, and activities to be managed directly by FAO. Other counterpart funds will finance direct projects costs such as training, commodities operation, support, consultation and studies, as outlined in Table 4.

2.2.3. Recurrent Costs

New GOS recurrent costs have been minimized in the design of the project, essentially by reorganizing current GOS resources (personnel, equipment and supporting costs) to create a locust control unit. A major assumption of the project design is that the GOS cannot afford, in the short or medium term, to support the recurrent costs required to operate a large unit, staffed continuously to combat major locust infestations. Therefore, the most economical use of meager GOS resources is the creation of a small core locust control unit which can be supplemented by seconded PPD personnel and external donor resources during locust emergencies.

Therefore, the GOS will need to absorb few project costs post project completion. These include the equivalent of about $20,000 per year to continue training activities in locust control operations for the core staff and potentially seconded personnel.

The success of the core locust control activity will be measured, inter alia, by a more efficient use and thus decreased use of pesticides during low locust infestation periods. This should mean a reduction in related recurrent costs for normal survey and control operations in real terms.

Table 5 below shows the annual Recurrent Costs for core locust control activities one year after project completion. These figures are based on normal survey and control operations (low infestations) and does not provide funds for an emergency situation.

Table 5

Post Project Annual Recurrent Costs
Core Activities Only
(Shown in Sudanese Pounds)

	Sudanese Pounds (LS)
Salaries and Allowances	
3 Admin. personnel x 7,200/year	21,600
20 Technical personnel x 6,600/year	132,000
26 Support personnel x 5,340/year	138,840
Total	292,440
Pesticides	
ULV (Fenitrothion 96%) 15MT x 45,000	675,000
EC (as above or equivalent) 1MT x 45,000	45,000
Aircraft Hire	
120 hours x 4,000/hr	480,000
Diesel	234,000
Vehicle and Equipment Maintenance	300,000
Training	90,000
Other	150,000
TOTAL	2,266,440

2.2.4. Per Diem Supplement

In order to ensure the success of the newly created LCU, it is recognized by both the PPD and the donors that some mechanism must be created to compensate LCU and PPD staff for possible long-term field duty in the event of a major infestation. The existing GOS per diem rate of LS 7 is clearly inadequate. Without some augmentation of per diem, local staff may well be reluctant to spend time in the field.

As a temporary correction to this situation, the project proposes the payment of a per diem supplement. The per diem supplement is considered a

salary supplement under AID policy, therefore approval by AA/AFR of the supplement was obtained (STATE 258583, August 10, 1988).

The per diem supplement will be paid in the event of a major locust infestation requiring extensive and prolonged field service. Such a per diem supplement would apply to all LCU staff, not just to those who are required to augment the LCU core unit. The per diem supplement would only become payable when:

- The Ministry of Agriculture proclaims the existence of an emergency situation due to a major locust infestation, and
- Staff field time exceeded seven consecutive days.

The per diem supplement will be paid in accordance with previous donor financed payments, i.e. a maximum of LS 50 per day, scaled according to the job requirements. (In all cases, the per diem plus the supplement will not exceed the per diem rate set by U.S. Government regulation.) The supplement payments will be payable from counterpart funds sources from USAID/GOS jointly programmed local currency fund and disbursed by the Ministry of Agriculture. FAO approval in principle has been obtained, although FAO shares AID policy concern regarding the payment of such supplements.

Since the per diem supplement is envisioned as an emergency provision, it is not a normal recurrent expense. Therefore, it is not expected to become a part of the GOS regular recurrent budget. However, the issue of adequate field allowance will need to be addressed by the GOS in its general discussions on government expenditures in accordance with its planned economic recovery program.

2.3. Financing Plan

2.3.1. AID Obligation and Disbursement Schedule:

AID proposes to obligate its total contribution to the core project by signing a grant agreement with the GOS and a subgrant with FAO in FY 1988. AID proposes to disburse its foreign exchange to FAO through periodic releases of 90 days cash requirements, as requested by FAO according to its workplan and projected expenditure pattern. A projected foreign exchange expenditure pattern follows in Table 6.

TABLE 6

Projected Expenditure Pattern
($000)

FY 1988 (4 mos)	FY 1989	FY 1990	FY 1991
500	800	650	50

27x

2.3.2. GOS Disbursement of Local Currency

The GOS will transfer $3,679,900 in counterpart funds to the PPD account, according to the existing USAID/GOS procedures for programming the GOS-owned local currency funds. Of this amount, PPD will release the equivalent of $799,300 to FAO for its local project expenses. The procedures for the request of local currency counterpart financing will require that FAO and PPD submit a six-month workplan and budget to the Ministry of Finance and Economic Planning Local Currency Committee biannually for review and approval. USAID participates in the review and approval. The GOS will make disbursements in accordance with the approved workplan and budget. FAO and PPD will be responsible for the regular accounting of funds and the submission of financial reports to the Local Currency Committee.

2.3.3. Methods of Implementation

The Plant Protection Department will implement the core locust control component with technical, administrative and logistical assistance from FAO/Rome. FAO will manage a multi-donor fund for the core activities, coordinate parallel donor inputs, and conduct all procurement of services and commodities. In accordance with AID Handbook 13, Chapter 5, AID will accept FAO's procurement regulations.

AID's foreign exchange contribution of $2,000,000 will first be granted to the GOS and apportioned as follows: AID will sub-grant a total of $1.8 million dollars to the multi-donor pool of funds for technical assistance, commodity procurement, aircraft hire and FAO evaluation and monitoring. AID and GOS will retain control of an additional $200,000 to be held separately from the multi-donor fund in order to finance activities such as to satisfy AID requirement for environmental and health monitoring, pesticide bank feasibility study special research and evaluation criteria. These activities, as described in the environmental and social soundness analysis, will be jointly approved by the GOS and AID.

FAO will have the discretion to adjust budget line items by 10% without prior donor approval. Adjustments greater than 10% will require approval by the Steering Committee and the contributing donors. Budget questions will be reviewed by the task force of the Steering Committee.

The following donors plan to contribute funds directly to FAO for the core activities and thus will execute bilateral grant or sub-grant agreements with FAO:

- AID: $1,800,000
- Netherlands: $940,000
- EEC: $1,546,000

The ODA intends to make a parallel contribution of $1,436,000 (vehicles and pesticides) directly to the GOS for use in project activities. The Government of Canada will enter into a grant directly with FAO or with the GOS.

AID's proposed grant agreement with FAO is described fully under Section 6, Conditions and Covenants.

2.3.4. Audit Coverage

The Grantee confirms that this program will be subject to an independent audit by the United Nations Board of Auditors and agrees to furnish copies of these audit reports to A.I.D. along with such other related information as may be requested by A.I.D. with respect to questions arising from the audit report.

3. Implementation Plan

AID assistance to the multi-donor component of the Core Locust Control Project will be first by means of a grant to the GOS to be followed by an AID sub-grant to FAO, an international organization as defined by Handbook 13. As such FAO, will use its own procurement system. No waiver of AID procurement regulations will be required.

The grant to FAO will be substantively backstopped and managed by the Directorate for Emergency Locust Control Operations based at FAO headquarters in Rome. The FAO, Khartoum Office will serve solely as an administrative office for the project.

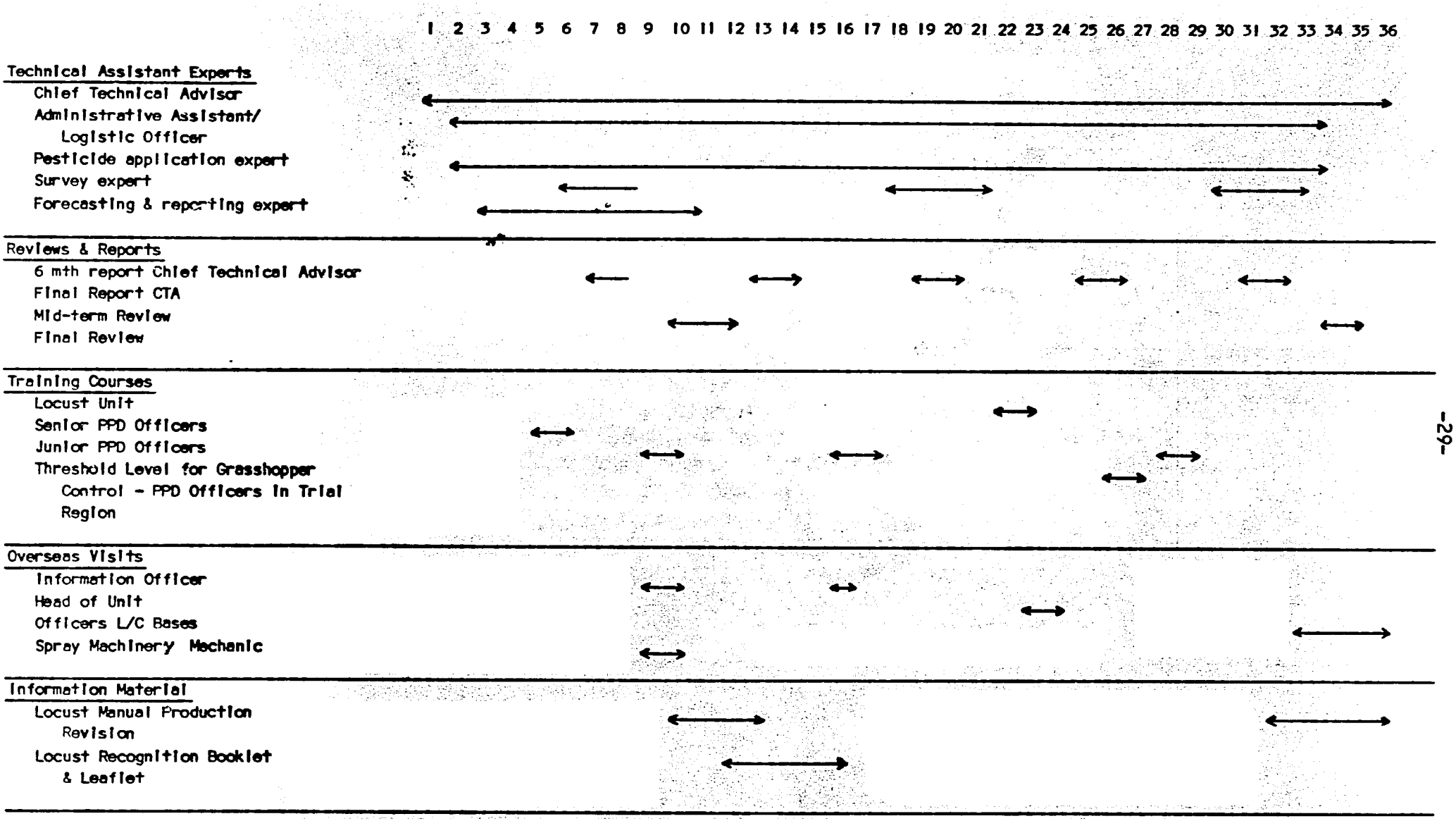
All procurement will be by international tender by FAO/ Rome, which will also arrange for shipment to Sudan and from port of entry to the various LCU warehouse sites within the country. Pesticides to be procured under the grant could include fenitrothion maluthion and carboryl, along with those listed in section 6.1 of the Environmental Assessment. All these pesticides are on the FAO approved list and have been approved by AID and the Environmental Protection Agency.

Disbursement under the grant will be by means of periodic advances, for both foreign exchange and AID funded local currency. As part of conditions for disbursement, FAO will submit a life of project work plan. Based on this plan, FAO will submit a ninety-day budget upon which AID will base its periodic advance. Within one month following end of the period covered by the advance, FAO will liquidate such advances through submission of a certified disbursement report summarized by core project inputs (i.e., Technical Assistance Training Commodities and other costs).

3.1. A schedule of major events is attached as follows:

PAR TTWO

Attachment 1



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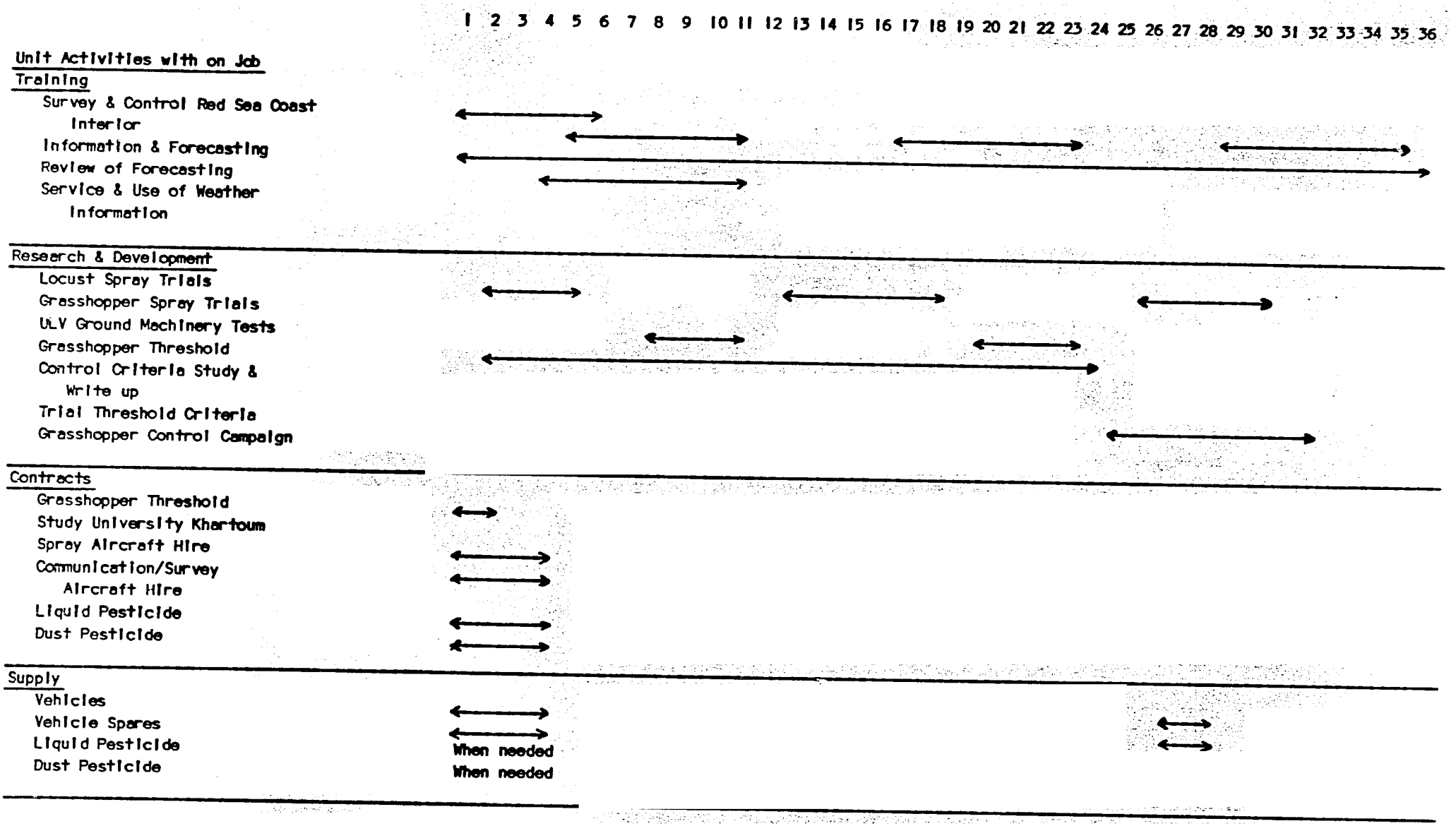
SCHEDULE OF MAJOR EVENTS



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4. PROJECT MONITORING

The overall monitoring of the Medium Term Locust Control Project will be accomplished through the Steering Committee. The Locust Control Steering Committee will meet monthly to review progress of the project. The Steering Committee mechanism has been in place for two years and has proven to be remarkably effective. However, there are various other monitoring tools to be utilized in the event that the Core Locust Unit is involved in control operations. Some of the following monitoring duties are tied closely with training procedures. The training procedures are designed to be implemented at the beginning of the Medium Term Locust Control Project and continue through its life.

Monitoring of the core locust activity consists primarily of two areas: These are efficacy and environmental safety.

4.1. Efficacy Monitoring

The efficacy monitoring will be the responsibility of the FAO Application and Control expert. He will coordinate and work directly with the LCU officer-in-charge to develop a plan for monitoring the efficacy of the control operation on an ongoing basis. Results of this monitoring will provide information for future control operations. This information should include insecticides used, rate of application, locust stage of development, vegetative conditions, climatic conditions, application equipment specifics and the degree of control achieved. By compiling this data and evaluating it, more efficient and effective control programs can be designed for future use. In addition, this information will be beneficial to supplement the data collected from research trials on pesticides and equipment for locust control.

4.2. Environmental/Safety Monitoring

The environmental/safety monitoring is designed as a separate USAID function, outside the umbrella of the Core Locust Activity. This mitigation consists of three parts, the first being monitoring by an environmental monitoring specialist. This individual's effort shall be organized in such a way as to entail environmental and biological monitoring of the pesticide application program. Working in cooperation with the FAO and PPD, the individual will be responsible for planning and conducting appropriate pre- and post-application environmental monitoring of select areas. Pre- and post-monitoring of beneficial species, including parasites and predators as well as other species of plant and animal life will be executed. The individual will conduct one monitoring program for each locust control campaign during the life of the project in which such services are deemed necessary.

The second part of the environmental/safety monitoring will involve the use of the pesticide safety specialist. This person will conduct training sessions, in cooperation with PPD or FAO, for the Locust Control Unit employees for the safe handling and management of pesticides in the locust control program. This includes on-the-job training at the five regional

headquarters. While on site, he will observe and monitor handling and safety practices.

The third area of monitoring in the mitigation outline in the EA is worker health. A majority of the insecticides likely to be used in a control program are known cholinesterase inhibitors. Cholinesterase-inhibiting insecticides, whose repeated or prolonged exposure to humans, can cause an inhibition of the human body to produce cholinesterase, which is an enzyme that hydrolizes acetylcholinesterase to form acetic acid and choline, vital elements to the nervous system. Therefore provisions for a health specialist have been made. This person shall be responsible for conducting a training program in the use of the Lovibond Test Kit for select PPD technicians assigned to the current locust control campaign. The research specialist shall assist PPD in the development and implementation of a program for the protection of workers at risk due to high body burdens of cholinesterase-inhibiting pesticides, based on the data collected using the Lovibond Kit. The person will also advise PPD on administrative and management techniques for timely and effective use of worker monitoring results by means of appropriate methods of data management and handling. In addition to this, provisions are made for the procurement of 15 Test Kits and related supplies. It is anticipated that environmental/safety monitoring assistance will be provided through local sources and be funded out of Trust Funds.

5. Summaries and Conclusions from the Annexes

The annexes to this paper which are summarized below support the conclusion that this portion of the project is technically, institutionally and economically viable. In addition, the Environmental Assessment (EA) finds the project to be environmentally sound, causing minimal adverse environmental impact. This project will therefore allow the Government of Sudan the opportunity to control locust infestations in a manner which will give the most efficacious results while assuring the safety of those charged with the handling and application of pesticides and the protection of the environment. These annexes will be further addressed by the pesticide disposal ammendment.

5.1. Summary of Financial Economic Analysis

Costs and benefits of the project can be estimated under a range of assumptions which for this analysis have been designed to cover the most likely eventualities regarding level of infestation and efficiency of control. Assumptions, scenarios, and graphic representations for scenarios are explained in detail in Annex D.

Table 6 shows that average annual benefits vary from near zero (light infestation, 30% control) to 23 million per year (heavy infestation, 70% control) over the range of scenarios presented. Internal Rate of Return varies from 7% to 299% over the same range of scenarios. Control is not expected to reach the 70% level. The indicators at the light infestation level are not entirely appropriate as they do not reflect benefits from locust

damage prevented by heading off heavier infestation or plagues. With this in mind, a reasonable range of financing indicators is as follows:

	LOW	HIGH
IRR%	50	200
Av. Annual Net Benefits (000,000 $)	3	15
Av. Annual Gross Benefits (000,000 $)	4	18

This means that locust control, as envisioned in this project, can reasonably be expected to save at least an average of four million dollars per year, on the average, in crop loss in Sudan. Locust Control might save up to 18 million dollars per year if the locust infestation is exceptionally heavy. Discounted returns, as measured by IRR, are attractive. Savings in crop loss can reasonably be expected to exert positive effects on the food supply and indirectly on the pricing mechanism and government price policy.

TABLE 6

SUMMARY OF FINANCIAL INDICATORS
(IRR %; AVERAGE ANNUAL NET AND GROSS BENEFITS
IN MILLION U.S. $$)

EFFECTIVENESS OF CONTROL		LEVEL OF INFESTATION LIGHT	MEDIUM	HEAVY
30%	IRR%	7	76	96
	Net Benefits/yr	-	3	8
	Gross Benefits/yr	1	4	11
50%	IRR%	42	146	187
	Net Benefits/yr	1	6	15
	Gross Benefits/yr	2	7	18
70%	IRR%	70	210	299
	Net Benefits/yr	2	9	23
	Gross Benefits/yr	3	10	26

Additional scenarios, reflecting the possibilities of changes in the schedule of benefits and costs (due to changes in crop value, cost overruns, etc.) result in economic indicators within the reasonable range shown above.

Tables and charts in Annex A allow easy financial re-evaluation at later stages of the project.

A final scenario, based on a technical assessment of most likely eventualities over the next ten years, produce an IRR of 155%, average annual benefits of 3.8 million dollars and average annual gross benefits of 5.9 million dollars.

Programmatic Environmental Assessment of Locust and Grasshopper Control in Africa and Asia (TAMS/CDCP, 1987), suggests that a sustained locust plague could cause hundreds of millions of dollars in crop loss throughout the region if unchecked. A reasonably effective regional locust control program could prevent most of this damage, especially if it is maintained in the recession stage for monitoring activities and is able to respond quickly in times of upsurge. Empirical treatment of benefits and costs to prevention is not possible but it is clear that the costs of effective control could not be borne by the principal beneficiaries - the farmers. It is also evident that most countries affected by locusts cannot bear the costs of locust control and that donor assistance will be necessary.

5.2. Summary of Technical Analysis

The combined efforts of donor organizations, including USAID, EEC and the Netherlands in cooperation with FAO and GOS, PPD have resulted in the formation of a Locust Control Unit. The following is a summary of the Technical Analysis, Annex E. This analysis has examined the functional aspects of the Unit and the resulting Medium Term Project, and identifies specific practices which will lead to a technically sound locust control program. This analysis concentrates primarily on the Desert Locust as this is the major pest, but other locusts and grasshoppers are also addressed.

The organization of a campaign is a key activity but one about which it is difficult to be specific. A clear chain of command, good communications and technical competence are essential pre-requisites for good campaign organization.

The Locust Core Unit should use less people than are currently occupied with locust control. It would, however, need a level of equipment, especially vehicles, much above the average for PPD. Whether or not future limited donor input will be needed will become known towards the end of the project.

Sudan acknowledges regional responsibilities by its membership in Desert Locust Control Office for East Africa (DLCO/EA). This organization should help member countries mainly by the supply of aircraft in times of emergency, however, DLCO/EA has been an unreliable supplier. Sudan has an international obligation to combat desert locust within its borders as part of the normal fight against this pest. Sudan has a specific responsibility to supply information to the Desert Locust Information Services (DLIS) of FAO.

The basic method of survey will be by a ground survey team using vehicles. Relatively simple information on numbers, stage of development and state of the habitat will be transferred daily by radio to HQ in Khartoum. Use will be made of aerial surveys to detect green areas where breeding may be

taking place. The locust information, together with weather data will be analysed by the Information Officer in Khartoum and presented daily to a senior officer. A biomonthly digest will be prepared during upsurges and plagues. A monthly bulletin will be prepared. Information will be transferred as rapidly as possible to FAO (DLIS) in Rome. Redonnan light traps are likely to be used, however remote sensing may be used to estimate areas of recent rain and green vegetation.

Survey and spray aircraft should be provided under long term contracts which stipulate the technical requirements of the aircraft. Insecticides should be similarly supplied under a long term contract whereby stocks are held by the suppliers and air freighted to Sudan only when needed. FAO is currently studying this situation. New ground sprayers will be assessed especially for robustness and ease of operation.

The insecticides utilized in this program will be those identified in the text of the analysis and which conform to the EA. Due to past successes in Sudan, Fenitrothion will be the prime material used, however field tests will be conducted on alternative compounds to allow integration of these insecticides into a successful prescription treatment program.

Virtually all control will be by Ultra Low Volume (ULV) methods. Aerial control will use Micronair (or similar) rotary cage atomizers and will be carried out only in a steady wind. Ground control is likely to be based on newly developed spinning cage and spinning disc vehicle mounted sprayers. Here also wind will be essential. Baiting and dusting will not be used.

There are four types of targets in locust control, they are:

1. Individual bands - these can be treated by ground spraying only.

2. Large blocks containing many bands - these are best sprayed by aircraft but can be treated by ULV ground sprayers.

3. Roosting swarms - these can be sprayed by ULV ground sprayers, but usually must be sprayed from the air.

4. Flying swarms - these can only be sprayed from the air.

Arguments about which method should be adopted are academic. All methods must be used since one method never overcomes an outbreak unless it is very small.

The training component of this Medium Term Locust Control Project, specifically as it relates to the Core Locust Control Unit is vitally important, and must be viewed, not only as an initial process, but an ongoing requirement. Four basic types of training will be implemented. On-the-job training will be the basis of the program. This will take place at all levels of the staffing and will be carried out by FAO Technical Advisors and the PPD

Officers. Emphasis will be on survey methods and especially on the safe use and handling of the pesticide in all phases of the project. More advanced training will be given to the Field Officer in the form of short courses, these conducted by FAO Technical staff. Short courses will also be provided to the regional entomologists, outlining their roles and responsibility and the basic elements of desert locust survey and control. Limited overseas trips to functional anti-locust organizations will be made available for officers will be provided short courses and on-the-job training to prepare them in the event they are called to duty during an upsurge or plague.

The migratory locust and the tree locust are minor problems confined to Sudan. A migratory locust plague might occur but it would start in West Africa, take some years to arrive and would need to be sustained by regular invasions.

The control of grasshopper is almost certainly a crop protection activity. However, it is not known whether control can save crops let alone produce savings at worthwhile cost. Research and development work would be devoted to deciding:

1. What infestations produce what crop less.

2. Whether eliminating the infestations will increase yield.

3. What are the best methods of control to produce that increase.

From this simple 'threshold' estimation criteria can be developed. Only then can a rational control system be developed utilizing peasant farmers. Meanwhile a simple survey system should be established to estimate general grasshopper distribution and incidence.

Locusts are very bad candidates for biological control. Even with grasshoppers there has been no case of successful biological control. Fungi are the best hope but they are unlikely to be successful unless applied directly to each target like a pesticide. Cultural methods might help to reduce grasshopper incidence.

The result of this analysis therefore indicates that a viable Core Locust Control Unit can be established within the PPD in Sudan. If the findings in this analysis are followed this unit should be equipped and trained to conduct regular surveys and control of locust during a recession period. In the event of an upsurge or a plague, the Unit is designed to expand to meet the need in an orderly and functional manner, with the emphasis being placed on efficacious and sound control programs.

5.3. Summary of Social Soundness Analysis

Locust control is a national/international issue. The primary beneficiary of this project is the newly formed Locust Control Unit of the Plant Protection Department. Secondary beneficiaries are those in the

agricultural sector (including pastoralists) and the people of Sudan as a whole, who will benefit from increased food security. Tertiary beneficiaries are those other countries who will benefit from the decreased locust infestations: locusts can attack large areas from West Africa to the Indian sub-continent.

Project participants are the PPD Locust Control Unit, the donors (through the Locust Steering Committee), and to a lesser extent than normal, small farmers, primarily through their reporting function.

Benefits will largely accrue to the PPD, through a strengthening of its institutional capacity to undertake normal survey and monitoring activities, and through an increased ability to mount effective campaigns. A major impact will be the improved information transmission capability. This will be accomplished through an organizational structure that clearly defines responsibilities and chains of command.

While the role of the agricultural sector is less than would normally be the case, due to the randomness of attacks, and the more national nature of the project, (which is not area specific), there is no need for control operations to be explained to local populations when they are in progress. This can be done through scouts, who are already PPD employees at the village level.

The greatest impact of control activities is most likely to be on the pastoral sector, and it is strongly recommended that information on livestock routes be collected, particularly for areas between the 350mm and 100mm rainfall isohyets, which is where the majority of control activities take place. An overall livestock route map should be constructed, preferably through the monitoring portion of the program, which will be handled through an appropriate local institution.

The project addresses safety issues, and due to lack of adequate health care facilities outside urban centers, this is a crucial part of the project, which can best be accomplished by on-the-job training.

A large portion of the impetus for the project has come from the donors and PPD, through the Locust Steering Committee, and there is agreement that the project is a necessary adjunct to improved performance of PPD overall. Those in the agricultural sector stand only to benefit, whether directly through crop savings, or indirectly through increased food security.

5.4. Summary of Institutional Analysis

The implementation of this core locust component require that various levels of the participating institutions function in coordination with each other. These entities include the donors, the Steering Committee, FAO, GOS, MOANR, PPD and LCU. The donors, consisting of GOS, the Government of the Netherlands, the EEC, AID, the Government of Canada and ODA, must all be committed to the project and make available their respective contribution in a timely manner. This coordination has been a reality in the recent past, embodied in the operations of the Locust Steering Committee.

The Steering Committee, which has representatives from the entities listed above, will function as an advisory board. The past record of the Steering Committee has been excellent and their guidance has been very valuable over the last two years.

FAO, as the implementing agent for the donors, has vast experience in locust control and locust control programs in Africa. They will manage the core locust component of the project through the three years of its life. This will be accomplished by providing technical staff and technical assistance in the areas of operations and training.

The GOS, MOANR, and PPD is charged with a commitment to insure that the LCU is maintained and managed as an autonomous unit within the PPD, in terms of personnel, budget and operations and equipment and supplies. They will also ensure that in the core of a locust upsurge or plague, that other units of PPD may be mobilized to assist the LCU. This mobilization, overseen by the MOANR, will be directed by the head of PPD in consultation with the head of the LCU and the FAO Chief Technical Adviser. This mobilization will include the secondment of personnel and the temporary reallocation of equipment and other supporting resources from the various divisions within PPD. This mobilization is expected to be successful since no new institutional linkages will be required; all major resources will come from within MOANR.

The vital segment of the institutional soundness of this core control activity, falls into the hands of the newly created Locust Control Unit. With the assistance of all the agencies named above, the LCU will be charged with conducting locust surveys, information collection and analysis, prosecution of field campaigns, field testing of insecticides, testing of vehicle mounted ULV sprayer and improving safety procedures. In the case of an upsurge, this unit will be the backbone of the control operation which will activate seconded officers. This will require motivation and dedication by the people selected to work in this unit through the creation and training of a pool of PPD officer in locust survey and control and the provision of additional field support.

The LCU will have a single mission and a structure allowing for more timely processing of information and for swift reaction to that information. The project has been designed to rely on appropriate technology, to have no inflationary impact on local factor costs, to be designed on an appropriate scale, and to be planned within an adequate time frame.

For the MTLC project to be totally successful, the three remaining components must be executed. These are; pesticide store rehabilitation, pesticide store stocking procedures and pesticide disposal. The bilateral agreement between the Government of the Netherlands and the GOS for the pesticide store rehabilitation and pesticide store stocking procedures is in place and the plan by the Netherlands is in line with the goals of the Medium Term Locust Control Project. AID will be amending this PP in 1989 to include the pesticide disposal activity.

5.5. Summary of Environmental Analysis

An essential part of an activity such as the Medium Term Locust Control Project is an assessment of its environmental validity and consequences. The following is a summary of this analysis which investigates the proposed action, the environment to be affected, the assessment and impact of the action and proposed mitigations of the impact.

The EA was prepared as a critical element of the project design, in compliance with AID's environmental procedures 22 CFR 216. The EA identifies and analyses the environmental and health/safety issues of the proposed project. The PEA LIG (TAMS/CICP, 1988)* forms the technical basis for the findings and recommendations of the EA, including a determination of the scope of the technical and policy issues to be examined in assessing the environmental impacts of large scale use of insecticides for locust in Sudan.

Sudanese laws and regulations concerning pesticide use and environment have been reviewed and the core locust component of the project as it is designed is in compliance with these articles.

Five possible technical control alternatives were considered; no action, non-chemical control, biological control, chemical control and integrated pest management (IPM). The PEA LIG TAMS/CICP, previously mentioned deals in detail with these alternatives. It is the findings of this EA that there are actually only two alternatives, those being no control or chemical control. Non-chemical control, i.e. mechanical, is time-consuming, expensive and impractical in a large scale locust control program. Biological control was eliminated due to the lack of sound scientific data proving its efficacy and workability in large scale programs. Biological control should be considered in the future if breakthroughs in research prove it to be viable alternative. This research is foreseen under the USAID/W regional research project. The IPM alternative was rejected due to its need for the incorporation of biological and mechanical methods. The alternative of no action has serious negative national and regional implications, ranging from economic, political, to environmental. Therefore, a judicial use of selected insecticide in a well managed and technically sound program is the clear action to be taken.

Sudan is a large country, with a very diverse environment. The majority of locust outbreaks take place in the northern two-thirds of the country. Included in this area are several national parks, refuges and sanctuaries. These institutions must receive detailed consideration before a decision is made for locust control in or near their boundaries.

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* This is the Programmatic Environmental Assessment for Locust and Grasshopper Control in Africa and Asia, written by TAMS Inc. and the Consortium for International Crop Protection in 1988.

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The technical implementation of the action was reviewed. Aspects including selection of insecticides, application equipment, effect on the environment and non-target organisms and the ability of the GOS, PPD were evaluated, as they relate to a safe and environmentally sound project. These issues are addressed in depth in the EA and recommendations made to minimize the environmental impact, while allowing for a viable, efficacious locust control program.

Environmental mitigation measures under this project include provisions for technical expertise in the areas of environmental monitoring, pesticide use training, safety and health. It is intended that these individuals work closely and in collaboration with both PPD and FAO. Activities include such things as monitoring for impact of the program on non-target and beneficial species and animal and plant life. Provisions have been made for both training and monitoring of those individuals involved in handling, loading an application of the insecticides, to ensure the safe use of the insecticides. These mitigation measures also include special procedures for control programs in or near ecologically sensitive areas. Physical procurement will include test kits and supplies for cholinesterase monitoring of select individuals.

6. Conditions and Covenants

The grant to FAO will be subject to the following conditions:

Provide proof that the Government of Netherlands, EEC and any other donors have entered into agreements with FAO providing donor commitment to implement the core project.

Within ninety days after the satisfaction of initial conditions precedent to disbursement, FAO will provide a detailed implementation and procurement plan for the core project. This plan will contain details on all aspects of the grant including monitoring and evaluation arrangements to be utilized under the grant.

FAO agrees to abide by all environmental procedures stipulated in the Environmental Assessment which is part of this project.

7. Evaluation Plan

The operational and environmental aspects of the project will be monitored by the Locust Steering Committee on an on-going basis. There is a need, however, for a more policy-based annual internal evaluation. This should be scheduled to coincide with the end of the summer campaigns (October). The review team should be composed of the following steering committee members: FAO Chief Technical Advisor, PPD Director, Head of the LCU, USAID Project Officer, EEC representative and a representative of the Royal Netherlands Embassy.

The first review will be held in October 1989 and should address the following implementation issues:

a. Improvement (if any) in survey and reporting;

b. LCU effectiveness in organising campaigns;

c. PPD pesticide storage and handling methods;

d. Cost effectiveness of Locust Control activities;

e. Logistical problems, particularly clearing and material handling;

f. Review of project staff performance;

g. Proposed annual work plan; and

h. Effect of project on overall PPD performance.

FAO has budgeted four person months of evaluation and monitoring time, which will follow their established procedures. The results of this will be made available to USAID.

AID and FAO should complete an external evaluation upon project completion. The evaluation will address whether or not the project objectives have been achieved. The scope of work for the evaluation will be developed jointly by AID and FAO. The outside entity that will perform the evaluation will be determined jointly by AID and FAO.

LOGICAL FRAMEWORK
FOR
SUMMARIZING PROJECT DESIGN

Annex A

Est. Project Completion Date FY 1991
Date of this Summary July 1, 1988

Project Title: MEDIUM TERM LOCUST CONTROL PROJECT (650-0087)

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program Goal: The broader objectives to which this project contributes: To contribute to increased food availability by establishing the institutional capacity for GOS to effectively implement locust and grasshopper control activities and to maintain safe handling, storage and use of pesticide.	Measures of Goal Achievement: 1. Reduction in the number and magnitude of locust and grasshopper swarms in Sudan. 2. Reduction in the number of locust swarms escaping to neighboring countries. 3. Minimal crop damage from locusts and/or grasshoppers. 4. Participation of appropriate GOS Ministries in the control of pesticides in Sudan.	1. Comparison of historical records of locust and grasshopper populations. 2. Analysis of swarm location reports. 3. Analysis of Ministry of Agriculture crop damage reports. 4. Analysis of swarm reports from neighboring countries.	Concerning long term value of program/project: 1. That international organizations will be effective in worldwide locust and grasshopper surveillance. 2. That the Sudan program will be implemented in collaboration with those of neighboring countries.
Project Purpose: 1. Strengthen the capabilities of PPD to predict and control locust and grasshopper outbreaks. 2. To develop a structure within PPD for the safe handling, storage, and use of pesticides.	Conditions that will indicate purpose has been achieved: End of project status. 1. PPD is implementing improved recession survey for desert locust, especially during summer; 2. PPD is organized to mount quickly a large Locust campaign at short notice, using ULV method. 3. PPD is utilizing improved labor intensive ground control operations in times of upsurge. 4. PPD is utilizing a reduced quantity of liquid pesticides used in locust control through better application methods. 5. PPD is effecting a reduction in cost of locust control due to the use of appropriate pesticides and application rates. 6. PPD is implementing a cost-effective grasshopper control system. 7. Pesticides application health risk is reduced to operators and by standers	1. Review of PPD performance in relation to Steering Committee and Task Force recommendations and actions. 2. Analysis of same records and reports as for goal verification above.	Affecting purpose to-goal link: 1. That the various donors involved will provide the expected inputs. 2. That the stability and continuity of the Sudan government will facilitate the international cooperation needed to implement the project. 3. Qualified staff will continue to operate in the Locust Control Unit. 4. PPD will continue to follow pesticide safety in handling application procedures.

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	8. PPD staff is correctly handling and storing pesticides according to acceptable safety and health standard. 9. PPD is implementing locust control program at acceptable minimum stock levels. 10. PPD is maintaining safely located and constructed pesticides stores.			
Outputs: 1. Core Locust Control Component a. locust control unit (LCU) and five regional bases established. b. reserve of skilled field officers created. c. staff trained in ground and air survey and control methods, pesticide safety and handling. d. staff trained in locust information analysis and forecasting. e. production of field operations manual. f. grasshopper threhold study produced. 2. Pesticide Disposal "to be designed later" 3. Rehabilitation of pesticide stores - pesticide stores rehabilitated and relocated and newly-constructed. 4. Pesticides stores stock procedures improvement a. PPD logistical unit reorganized. b. administrative system instituted. c. PPD pesticide stores personnal trained.	Magnitude of Outputs necessary and sufficient to achieve purpose: 1.a. Unit staff (29) selected and trained, budget established, and vehicles and equipment purchased and allocated. b. 30-40 PPD Officers trained in Locust survey, control techniques and safe handling of pesticides through short courses and secondment to LCU. c. Unit staff trained through short courses, on-the-job training, and overseas fours to observe locust control operations in Saudi Arabia and Australia. d. LCU information officer and 29 staff members of unit trained through formal course, in-job-training and and field visit to FAO information unit in Rome (Lcu info. officer only). e. 1 field manual produced by Chief Technical Adviser, incorporation all aspects of field operations. f. cost-conscious control measures for grasshoppers established. 2. To be determined. 3. 14 pesticides stores rehabilitated. 15 pesticides stores newly constructed. 4.a/b Transport and logistics sections of PPD operating as one unit, under logistics manager. c. 35 store Keepers and head-quarters staff trained in pesticides logistics (inventory Control, warehousing, and transport).	1. Project evaluations. 2. Examination of PPD staffing operating procedures. 3. Examination of PPD reports. 4. Field visits.	Affecting output-to-purpose 1. The PPD will be provided with qualified technical staff and adequate budgetary support to sustain the organization. 2. The PPD will be reorganized to establish separate Locust Unit and support the Pesticides Safety Office.

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Inputs: Activities and Types of Resources:	Level of Effort/Expenditure for each activity.			Affecting Input-to-Output Link:
1. Core locust control	1.a.	$1,120,000	1,632,300	1. Examination of receiving reports and arrival notices for commodities.	1. That participating donors will provide needed inputs according to the agreed implementation schedule.
a. personnel	b.	116,000		2. Technical assistance reports and briefings.	
b. training	c.	3,406,000	3,572,500	3. Review of training completion reports.	
c. commodities	d.		2,370,500	4. Site visits and project review meetings.	2. That customs clearance procedures will not obstruct timely importation of commodities.
d. operational support	e.		533,300		
e. construction	f.	1,450,000	1,650,500		
f. other costs	g.		957,800		
g. contingency	2. To be determined				
2. Pesticide Disposal	3.	$3,200,000	2,211,200		
To be determined	4.a.	200,000	-		
3. Pesticides Stores Rehabilitation	b.	100,000	-		
contract, equip, supplies.	c.	-	27,400		
4. Pesticides Stores Stock Procedures Improvement.					
a.technical assitance					
b.training					
c.other costs					

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Khartoum : 27th August 1988 الخرطوم في :

Ref. : MFEP/USAID/162 النمـرة :

الموافـق :

Annex B

Director
USAID Mission
Khartoum

Dear Sir,

Subject: Multi-Donor Medium Term Locust Control Project

The Government of Sudan requests the assistance of USAID in the amount of $2,000,000 in grant for partial funding of the foreign exchange costs of the Multi-Donor Medium Term Locust Project. The project is an umbrella project for four activities, of which the core locust control component will be financed jointly by a number of donors. The grant will finance partially the costs for operating the core locust control component of the project which includes the creation of the Locust Control Unit of the Plant Protection Department of the Ministry of Agriculture and Natural Resources. We expect additional support for this component from other donors.

The core locust control activity will be implemented under the auspices of the FAO, and therefore we request that USAID enter into an agreement with FAO for the disbursement of the funds.

Additionally, in order to meet the local currency costs of the project, the Government of Sudan agrees to allocate the equivalent of $11,088,800, which includes the local currency equivalent of $3,679,900 in counterpart funds from which FAO will receive $799,300 equivalent, $126,000 in Trust Funds to USAID, and a GOS in-kind contribution of $7,282,900.

Your assistance is highly appreciated.

Sincerely yours,

El Sheikh El Khidir Ahmed
for First Undersecretary for Planning
Ministry of Finance & Economic Planning

Director
USAID Mission
Khartoum

Dear Sir:

Subject: Multi-Donor Medium Term Locust Control Project

The Government of Sudan requests assistance in the amount of $2,000,000 in grant for partial funding of the foreign exchange costs of the Multi-Donor Medium Term Locust Project. The project is an umbrella project for four activities, of which the core locust control component will by financed jointly by a number of donors. The grant will finance partially the costs for operating the core locust control component of the project which includes the creation of the locust control unit of the Plant Protection Department of the Ministry of Agriculture and Natural Resources. We expect additional support for this component from the Netherlands Government, the European Economic Community and other donors.

The core locust control activity will be implemented under the auspices of the FAO, and, therefore, we request that USAID enter into a grant agreement with FAO for the disbursement of the funds.

Additionally, in order to meet the local development costs of the project, the Government of Sudan agrees to release LS 2,756,300 to the FAO from the USAID/Government of Sudan jointly held local currency generations. We will release these funds to FAO in accordance with our agreed programming and release procedures for the duration of the project. Also, we agree to

continue recurrent budgetary support to the newly created locust control unit after the project's completion.

Your assistance is highly appreciated.

Sincerely yours,

Under Secretary for Planning
Ministry of Finance and Economic
Planning

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ANNEX B

PLANT PROTECTION DIRECTORATE
Min. of Agriculture and Irrigation
P.O. Box 14
Khartoum North
Tel : 32630 — 34520 — 33844

وزارة الزراعة والرى
ادارة وقاية النباتات
ص.ب ١٤
الخرطوم بحرى
٣٢٦٣٠ — ٣٤٥٢٠ — ٣٣٨٤٤

.....30/6/1988.....

Ministerial Order

Since the Locust Control is a national issue , I hereby declare the Locust Control Unit (L.C.U.)is an autonomous body functioning under umbrella of Plant Protection Department (PPD), in terms of_:

- Personnel .
- Budget and operation.
- Equipment and supplies.

In case of of a locust upsurge or plaque , the other units of PPD shall be mobilized to assist the L.C.U. .

Dr. ElFatih Mohamed ElTiguni
Minister of Agriculyure &
Natural Resources.

Distribution:

- Chairman of the Locust Control Steering Committee
- FAO representation in Sudan .
- Director of PPD.

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ANNEX C

5C(1) - COUNTRY CHECKLIST

Listed below are statutory criteria applicable to: (A) FAA funds generally; (B)(1) Development Assistance funds only; or (B)(2) the Economic Support Fund only.

A. GENERAL CRITERIA FOR COUNTRY ELIGIBILITY — SUDAN - FY 1988

1. FY 1988 Continuing Resolution Sec. 526. Has the President certified to the Congress that the government of the recipient country is failing to take adequate measures to prevent narcotic drugs or other controlled substances which are cultivated, produced or processed illicitly, in whole or in part, in such country or transported through such country, from being sold illegally within the jurisdiction of such country to United States Government personnel or their dependents or from entering the United States unlawfully? — NO

2. FAA Sec. 481(h). (This provision applies to assistance of any kind provided by grant, sale, loan, lease, credit, guaranty, or insurance, except assistance from the Child Survival Fund or relating to international narcotics control, disaster and refugee relief, or the provision of food or medicine.) If the recipient is a "major illicit drug producing country" (defined as a country producing during a fiscal year at least five metric tons of opium or 500 metric tons of coca or marijuana) or a "major drug-transit country" (defined as a country that is a significant direct source of illicit drugs significantly affecting the United States, through which such drugs are transported, or through which significant sums of drug-related profits are laundered with the knowledge or complicity of the government), has the President in the March 1 International Narcotics Control Strategy Report (INSCR) determined and certified to the Congress (without — N/A

BEST AVAILABLE DOCUMENT

Congressional enactment, within 30 days of continuous session, of a resolution disapproving such a certification), or has the President determined and certified to the Congress on any other date (with enactment by Congress of a resolution approving such certification), that (a) during the previous year the country has cooperated fully with the United States or taken adequate steps on its own to prevent illicit drugs produced or processed in or transported through such country from being transported into the United States, and to prevent and punish drug profit laundering in the country, or that (b) the vital national interests of the United States require the provision of such assistance?

3. Drug Act Sec. 2013. (This section applies to the same categories of assistance subject to the restrictions in FAA Sec. 481(h), above.) If recipient country is a "major illicit drug producing country" or "major drug-transit country" (as defined for the purpose of FAA Sec 481(h)), has the President submitted a report to Congress listing such country as one (a) which, as a matter of government policy, encourages or facilitates the production or distribution of illicit drugs; (b) in which any senior official of the government engages in, encourages, or facilitates the production or distribution of illegal drugs; (c) in which any member of a U.S. Government agency has suffered or been threatened with violence inflicted by or with the complicity of any government officer; or (d) which fails to provide reasonable cooperation to lawful activities of U.S. drug enforcement agents, unless the President has provided the required certification to Congress pertaining to U.S. national interests and the drug control and criminal prosecution efforts of that country? N/A

4. FAA Sec. 620(c). If assistance is to a government, is the government liable as debtor or unconditional guarantor on any debt to a U.S. citizen for goods or services furnished or ordered where (a) such citizen has exhausted available legal remedies and (b) the debt is not denied or contested by such government? NO

5. FAA Sec. 620(e)(1). If assistance is to a government, has it (including any government agencies or subdivisions) taken any action which has the effect of nationalizing, expropriating, or otherwise seizing ownership or control of property of U.S. citizens or entities beneficially owned by them without taking steps to discharge its obligations toward such citizens or entities? NO

6. FAA Secs. 620(a), 620(f), 620D; FY 1988 Continuing Resolution Sec. 512. Is recipient country a Communist country? If so, has the President determined that assistance to the country is vital to the security of the United States, that the recipient country is not controlled by the international Communist conspiracy, and that such assistance will further promote the independence of the recipient country from international communism? Will assistance be provided directly to Angola, Cambodia, Cuba, Iraq, Libya, Vietnam, South Yemen, Iran or Syria? Will assistance be provided to Afghanistan without a certification? NO

7. FAA Sec. 620(j). Has the country permitted, or failed to take adequate measures to prevent, damage or destruction by mob action of U.S. property? NO

8. FAA Sec. 620(l). Has the country failed to enter into an investment guaranty agreement with OPIC? NO

9.	FAA Sec. 620(o); Fishermen's Protective Act of 1967 (as amended) Sec. 5. (a) Has the country seized, or imposed any penalty or sanction against, any U.S. fishing vessel because of fishing activities in international waters? (b) If so, has any deduction required by the Fishermen's Protective Act been made?	NO
10.	FAA Sec. 620(q); FY 1988 Continuing Resolution Sec. 518. (a) Has the government of the recipient country been in default for more than six months on interest or principal of any loan to the country under the FAA? (b) Has the country been in default for more than one year on interest or principal on any U.S. loan under a program for which the FY 1988 Continuing Resolution appropriates funds?	YES, SUDAN HAS FROM TIME TO TIME BEEN IN DEFAULT ON LOANS, BUT CONTINUES TO MAKE EVERY EFFORT TO MEET COMMITMENTS AND MAKES PAYMENTS WHEN FOREIGN EXCHANGE BECOMES AVAILABLE.
11.	FAA Sec. 620(s). If contemplated assistance is development loan or to come from Economic Support Fund, has the Administrator taken into account the percentage of the country's budget and amount of the country's foreign exchange or other resources spent on military equipment? (Reference may be made to the annual "Taking Into Consideration" memo: "Yes, taken into account by the Administrator at time of approval of Agency OYB." This approval by the Administrator of the Operational Year Budget can be the basis for an affirmative answer during the fiscal year unless significant changes in circumstances occur.)	YES, TAKEN INTO CONSIDERATION BY THE ADMINISTRATOR AT TIME OF APPROVAL OF FY 1988 OYB.
12.	FAA Sec. 620(t). Has the country severed diplomatic relations with the United States? If so, have relations been resumed and have new bilateral assistance agreements been negotiated and entered into since such resumption?	THE GOVERNMENT OF SUDAN SEVERED DIPLOMATIC RELATIONS WITH THE U.S. IN 1967, BUT SUCH RELATIONS WERE RESUMED IN 1972. THE 1958 BILATERAL ASSISTANCE AGREEMENT WAS CONFIRMED IN 1971 AND REMAINS IN EFFECT.

13. FAA Sec. 620(u). What is the payment status of the country's U.N. obligations? If the country is in arrears, were such arrearages taken into account by the A.I.D. Administrator in determining the current A.I.D. Operational Year Budget? (Reference may be made to the Taking into Consideration memo.)

THE EXISTENCE OF ANY ARREARS WAS TAKEN INTO CONSIDERATION BY THE ADMINISTRATOR AT THE TIME OF APPROVING THE FY 1988 OYB. SUDAN WAS NOT DELINQUENT WITHIN THE MEANING OF ARTICLE 19 OF THE U.N. CHARTER.

14. FAA Sec. 620A. Has the President determined that the recipient country grants sanctuary from prosecution to any individual or group which has committed an act of international terrorism or otherwise supports international terrorism?

NO.

15. FY 1988 Continuing Resolution Sec. 576. Has the country been placed on the list provided for in Section 6(j) of the Export Administration Act of 1979 (currently Libya, Iran, South Yemen, Syria, Cuba, or North Korea)?

NO.

16. ISDCA of 1985 Sec. 552(b). Has the Secretary of State determined that the country is a high terrorist threat country after the Secretary of Transportation has determined, pursuant to section 1115(e)(2) of the Federal Aviation Act of 1958, that an airport in the country does not maintain and administer effective security measures?

NO.

17. FAA Sec. 666(b). Does the country object, on the basis of race, religion, national origin or sex, to the presence of any officer or employee of the U.S. who is present in such country to carry out economic development programs under the FAA?

NO.

18. FAA Secs. 669, 670. Has the country, after August 3, 1977, delivered to any other country or received nuclear enrichment or reprocessing equipment, materials, or technology, without specified arrangements or safeguards, and without special certification by the President? Has it transferred a nuclear explosive device to a non-nuclear weapon state, or if such a state, either received or detonated a nuclear explosive device? (FAA Sec. 620E permits a special waiver of Sec. 669 for Pakistan.)

NO.

19. FAA Sec. 670. If the country is a non-nuclear weapon state, has it, on or after August 8, 1985, exported (or attempted to export) illegally from the United States any material, equipment, or technology which would contribute significantly to the ability of a country to manufacture a nuclear explosive device?

NO.

20. ISDCA of 1981 Sec. 720. Was the country represented at the Meeting of Ministers of Foreign Affairs and Heads of Delegations of the Non-Aligned Countries to the 36th General Assembly of the U.N. on Sept. 25 and 26, 1981, and did it fail to disassociate itself from the communique issued? If so, has the President taken it into account? (Reference may be made to the Taking into Consideration memo.)

SUDAN WAS REPRESENTED AND HAS NOT DISASSOCIATED ITSELF FROM THE COMMUNIQUE. THIS WAS TAKEN INTO CONSIDERATION BY THE ADMINISTRATOR AT THE TIME OF APPROVING THE FY 1988 OYB.

21. FY 1988 Continuing Resolution Sec. 528. Has the recipient country been determined by the President to have engaged in a consistent pattern of opposition to the foreign policy of the United States?

NO.

22. FY 1988 Continuing Resolution Sec. 513. Has the duly elected Head of Government of the country been deposed by military coup or decree? If assistance has been terminated, has the President notified Congress that a democratically elected government has taken office prior to the resumption of assistance?

N/A

23. FY 1988 Continuing Resolution Sec. 543. Does the recipient country fully cooperate with the international refugee assistance organizations, the United States, and other governments in facilitating lasting solutions to refugee situations, including resettlement without respect to race, sex, religion, or national origin?

YES.

FUNDING SOURCE CRITERIA FOR COUNTRY ELIGIBILITY

1. Development Assistance Country Criteria

FAA Sec. 116. Has the Department of State determined that this government has engaged in a consistent pattern of gross violations of internationally recognized human rights? If so, can it be demonstrated that contemplated assistance will directly benefit the needy? — NO

FY 1988 Continuing Resolution Sec. 530. Has the President certified that use of DA funds by this country would violate any of the prohibitions against use of funds to pay for the performace of abortions as a method of family planning, to motivate or coerce any person to practice abortions, to pay for the performance of involuntary sterilization as a method of family planning, to coerce or provide any financial incentive to any person to undergo sterilizations, to pay for any biomedical research which relates, in whole or in part, to methods of, or the performance of, abortions or involuntary sterilization as a means of family planning? — NO.

2. Economic Support Fund Country Criteria

FAA Sec. 502B. Has it been determined that the country has engaged in a consistent pattern of gross violations of internationally recognized human rights? If so, has the President found that the country made such significant improvement in its human rights record that furnishing such assistance is in the U.S. national interest? — N/A

FY 1988 Continuing Resolution Sec. 549. Has this country met its drug eradication targets or otherwise taken significant steps to halt illicit drug production or trafficking? — N/A

5C(3) - STANDARD ITEM CHECKLIST

Listed below are the statutory items which normally will be covered routinely in those provisions of an assistance agreement dealing with its implementation, or covered in the agreement by imposing limits on certain uses of funds.

These items are arranged under the general headings of (A) Procurement, (B) Construction, and (C) Other Restrictions.

A. PROCUREMENT

1. FAA Sec. 602(a). Are there arrangements to permit U.S. small business to participate equitably in the furnishing of commodities and services financed?

No. Project will be implemented through a grant to an international organization, AID will have no control over procuremen since AID, as directed by HB13, Ch.5, waives its procurement regulations in favor of that of the international organization.

2. FAA Sec. 604(a). Will all procurement be from the U.S. except as otherwise determined by the President or under delegation from him?

Procurement will be from AID Geographic Code 941, 899, and 935.

3. FAA Sec. 604(d). If the cooperating country discriminates against marine insurance companies authorized to do business in the U.S., will commodities be insured in the United States against marine risk with such a company?

N/A

4. FAA Sec. 604(e); ISDCA of 1980 Sec. 705(a). If non-U.S. procurement of agricultural commodity or product thereof is to be financed, is there provision against such procurement when the domestic price of such commodity is less than parity? (Exception where commodity financed could not reasonably be procured in U.S.)

No. Project will be implemented through a grant to a international organization, AID will have no control ove procurement since AID, as directed by HB 13, Ch.5, waives its procurement regulations in favor of tha of the international organization.

5. FAA Sec. 604(g). Will construction or engineering services be procured from firms of advanced developing countries which are otherwise eligible under Code 941 and which have attained a competitive capability in international markets in one of these areas? (Exception for those

N/A

countries which receive direct economic assistance under the FAA and permit United States firms to compete for construction or engineering services financed from assistance programs of these countries.)

6. FAA Sec. 603. Is the shipping excluded from compliance with the requirement in section 901(b) of the Merchant Marine Act of 1936, as amended, that at least 50 percent of the gross tonnage of commodities (computed separately for dry bulk carriers, dry cargo liners, and tankers) financed shall be transported on privately owned U.S. flag commercial vessels to the extent such vessels are available at fair and reasonable rates? — Yes

7. FAA Sec. 621(a). If technical assistance is financed, will such assistance be furnished by private enterprise on a contract basis to the fullest extent practicable? Will the facilities and resources of other Federal agencies be utilized, when they are particularly suitable, not competitive with private enterprise, and made available without undue interference with domestic programs? — Technical assistance will be obtained through international procurement by the international organization implementing the project.

8. International Air Transportation Fair Competitive Practices Act, 1974. If air transportation of persons or property is financed on grant basis, will U.S. carriers be used to the extent such service is available? — This is not applicable for projects implemented under HB 13, Ch.5 guidelines.

9. FY 1988 Continuing Resolution Sec. 504. If the U.S. Government is a party to a contract for procurement, does the contract contain a provision authorizing termination of such contract for the convenience of the United States? — N/A

10. FY 1988 Continuing Resolution Sec. 524. If assistance is for consulting service through procurement contract pursuant to 5 U.S.C. 3109, are contract expenditures a matter of public record and available for public inspection (unless otherwise provided by law or Executive order)? — N/A

B. CONSTRUCTION

1. FAA Sec. 601(d). If capital (e.g., construction) project, will U.S. engineering and professional services be used?	N/A
2. FAA Sec. 611(c). If contracts for construction are to be financed, will they be let on a competitive basis to maximum extent practicable?	N/A
3. FAA Sec. 620(k). If for construction of productive enterprise, will aggregate value of assistance to be furnished by the U.S. not exceed $100 million (except for productive enterprises in Egypt that were described in the CP), or does assistance have the express approval of Congress?	N/A

C. OTHER RESTRICTIONS

1. FAA Sec. 122(b). If development loan repayable in dollars, is interest rate at least 2 percent per annum during a grace period which is not to exceed ten years, and at least 3 percent per annum thereafter?	N/A
2. FAA Sec. 301(d). If fund is established solely by U.S. contributions and administered by an international organization, does Comptroller General have audit rights?	Since project is multi-donor financed, all audit rights are waived.
3. FAA Sec. 620(h). Do arrangements exist to insure that United States foreign aid is not used in a manner which, contrary to the best interests of the United States, promotes or assists the foreign aid projects or activities of the Communist-bloc countries?	Yes

4. Will arrangements preclude use of financing:

FAA Sec. 104(f); FY 1987 Continuing Resolution Secs. 525, 538. (1) To pay for performance of abortions as a method of family planning or to motivate or coerce persons to practice abortions; (2) to pay for performance of involuntary sterilization as method of family planning, or to coerce or provide financial incentive to any person to undergo sterilization; (3) to pay for any biomedical research which relates, in whole or part, to methods or the performance of abortions or involuntary sterilizations as a means of family planning; or (4) to lobby for abortion? Yes

b. FAA Sec. 483. To make reimbursements, in the form of cash payments, to persons whose illicit drug crops are eradicated?

c. FAA Sec. 620(g). To compensate owners for expropriated or nationalized property, except to compensate foreign nationals in accordance with a land reform program certified by the President?

d. FAA Sec. 660. To provide training, advice, or any financial support for police, prisons, or other law enforcement forces, except for narcotics programs?

e. FAA Sec. 662. For CIA activities?

f. FAA Sec. 636(i). For purchase, sale, long-term lease, exchange or guaranty of the sale of motor vehicles manufactured outside U.S., unless a waiver is obtained?

g.	FY 1988 Continuing Resolution Sec. 503. To pay pensions, annuities, retirement pay, or adjusted service compensation for prior or current military personnel?	Yes
h.	FY 1988 Continuing Resolution Sec. 505. To pay U.N. assessments, arrearages or dues?	Yes
i.	FY 1988 Continuing Resolution Sec. 506. To carry out provisions of FAA section 209(d) (transfer of FAA funds to multilateral organizations for lending)?	Yes
j.	FY 1988 Continuing Resolution Sec. 510. To finance the export of nuclear equipment, fuel, or technology?	Yes
k.	FY 1988 Continuing Resolution Sec. 511. For the purpose of aiding the efforts of the government of such country to repress the legitimate rights of the population of such country contrary to the Universal Declaration of Human Rights?	Yes
l.	FY 1988 Continuing Resolution Sec. 516; State Authorization Sec. 109. To be used for publicity or propaganda purposes designed to support or defeat legislation pending before Congress, to influence in any way the outcome of a political election in the United States, or for any publicity or propaganda purposes not authorized by Congress?	Yes

5C(2) - PROJECT CHECKLIST

Listed below are statutory criteria applicable to projects. This section is divided into two parts. Part A includes criteria applicable to all projects. Part B applies to projects funded from specific sources only: B(1) applies to all projects funded with Development Assistance; B(2) applies to projects funded with Development Assistance loans; and B(3) applies to projects funded from ESF.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE? HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PROJECT?

A. GENERAL CRITERIA FOR PROJECT

1. FY 1988 Continuing Resolution Sec. 523; FAA Sec. 634A. If money is sought to obligated for an activity not previously justified to Congress, or for an amount in excess of amount previously justified to Congress, has Congress been properly notified?

   CN expired without objection on May 18, 1988.

2. FAA Sec. 611(a)(1). Prior to an obligation in excess of $500,000, will there be (a) engineering, financial or other plans necessary to carry out the assistance, and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?

   Yes

3. FAA Sec. 611(a)(2). If legislative action is required within recipient country, what is the basis for a reasonable expectation that such action will be completed in time to permit orderly accomplishment of the purpose of the assistance?

   N/A

4.	FAA Sec. 611(b); FY 1988 Continuing Resolution Sec. 501. If project is for water or water-related land resource construction, have benefits and costs been computed to the extent practicable in accordance with the principles, standards, and procedures established pursuant to the Water Resources Planning Act (42 U.S.C. 1962, et seq.)? (See A.I.D. Handbook 3 for guidelines.)	N/A
5.	FAA Sec. 611(e). If project is capital assistance (e.g., construction), and total U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability to maintain and utilize the project effectively?	N/A
6.	FAA Sec. 209. Is project susceptible to execution as part of regional or multilateral project? If so, why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	N/A
7.	FAA Sec. 601(a). Information and conclusions on whether projects will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.	N/A
8.	FAA Sec. 601(b). Information and conclusions on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).	N/A
9.	FAA Secs. 612(b), 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized in lieu of dollars.	Yes

10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release? — No

11. FY 1988 Continuing Resolution Sec. 521. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar or competing commodity? — N/A

12. FY 1988 Continuing Resolution Sec. 553. Will the assistance (except for programs in Caribbean Basin Initiative countries under U.S. Tariff Schedule "Section 807," which allows reduced tariffs on articles assembled abroad from U.S.-made components) be used directly to procure feasibility studies, prefeasibility studies, or project profiles of potential investment in, or to assist the establishment of facilities specifically designed for, the manufacture for export to the United States or to third country markets in direct competition with U.S. exports, of textiles, apparel, footwear, handbags, flat goods (such as wallets or coin purses worn on the person), work gloves or leather wearing apparel? — N/A

13. FAA Sec. 119(g)(4)-(6). Will the assistance (a) support training and education efforts which improve the capacity of recipient countries to prevent loss of biological diversity; (b) be provided under a long-term agreement in which the recipient country agrees to protect ecosystems or other wildlife habitats; (c) support efforts to identify and survey ecosystems in recipient countries worthy of protection; or (d) by any direct or indirect means significantly degrade national parks or similar protected areas or introduce exotic plants or animals into such areas? — No

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14. FAA 121(d). If a Sahel project, has a determination been made that the host government has an adequate system for accounting for and controlling receipt and expenditure of project funds (either dollars or local currency generated therefrom)? N/A

15. FY 1988 Continuing Resolution. If assistance is to be made to a United States PVO (other than a cooperative development organization), does it obtain at least 20 percent of its total annual funding for international activities from sources other than the United States Government? N/A

16. FY Continuing Resolution Sec. 541. If assistance is being made available to a PVO, has that organization provided upon timely request any document, file, or record necessary to the auditing requirements of A.I.D., and is the PVO registered with A.I.D.? N/A

17. FY 1988 Continuing Resolution Sec. 51[illegible] If funds are being obligated under an appropriation account to which they were not appropriated, has prior approval of the Appropriations Committees of Congress been obtained? N/A

18. FY Continuing Resolution Sec. 515. If deob/reob authority is sought to be exercised in the provision of assistance, are the funds being obligated for the same general purpose, and for countries within the same general region as originally obligated, and have the Appropriations Committees of both Houses of Congress been properly notified? N/A

19. State Authorization Sec. 139 (as interpreted by conference report). Has confirmation of the date of signing of the project agreement, including the amount involved, been cabled to State L/T and A.I.D. LEG within 60 days of the agreement's entry into force with respect to the United States, and has the full text of the agreement been pouched to those same offices? (See Handbook 3, Appendix 6G for agreements covered by this provision).

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a.	FY 1986 Continuing Resolution Sec. 552 (as interpreted by conference report). If assistance is for agricultural development activities (specifically, any testing or breeding feasibility study, variety improvement or introduction, consultancy, publication, conference, or training), are such activities (a) specifically and principally designed to increase agricultural exports by the host country to a country other than the United States, where the export would lead to direct competition in that third country with exports of a similar commodity grown or produced in the United States, and can the activities reasonably be expected to cause substantial injury to U.S. exporters of a similar agricultural commodity; or (b) in support of research that is intended primarily to benefit U.S. producers?	N/A
b.	FAA Secs. 102(b), 111, 113, 281(a). Describe extent to which activity will (a) effectively involve the poor in development by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, dispersing investment from cities to small towns and rural areas, and	Project will assist the GOS to improve its survey and control of locust. Small farmers will benefit from this activity through the eventual reduction of crop damage due to locust infestations.

insuring wide participation of the poor in the benefits of development on a sustained basis, using appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward a better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries.

c. FAA Secs. 103, 103A, 104, 105, 106, 120-21. Does the project fit the criteria for the source of funds (functional account) being used? — Yes

d. FAA Sec. 107. Is emphasis placed on use of appropriate technology (relatively smaller, cost-saving, labor-using technologies that are generally most appropriate for the small farms, small businesses, and small incomes of the poor)? — No

e. FAA Secs. 110, 124(d). Will the recipient country provide at least 25 percent of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or is the latter cost-sharing requirement being waived for a "relatively least developed" country)? — Yes

f. FAA Sec. 128(b). If the activity attempts to increase the institutional capabilities of private organizations or the government of the country, or if it attempts to stimulate scientific and technological research, has it been designed and will it be monitored to ensure that the ultimate beneficiaries are the poor majority? — Yes

g. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental processes essential to self-government.

h. FY 1988 Continuing Resolution Sec. 538. Are any of the funds to be used for the performance of abortions as a method of family planning or to motivate or coerce any person to practice abortions? N/A

Are any of the funds to be used to pay for the performance of involuntary sterilization as a method of family planning or to coerce or provide any financial incentive to any person to undergo sterilizations?

Are any of the funds to be used to pay for any biomedical research which relates, in whole or in part, to methods of, or the performance of, abortions or involuntary sterilization as a means of family planning?

i. FY 1988 Continuing Resolution. Is the assistance being made available to any organization or program which has been determined to support or participate in the management of a program of coercive abortion or involuntary sterilization? N/A

If assistance is from the population functional account, are any of the funds to be made available to voluntary family planning projects which do not offer, either directly or through referral to or information about access to, a broad range of family planning methods and services?

j.	FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?	Yes
k.	FY 1988 Continuing Resolution. What portion of the funds will be available only for activities of economically and socially disadvantaged enterprises, historically black colleges and universities, colleges and universities having a student body in which more than 20 percent of the students are Hispanic Americans, and private and voluntary organizations which are controlled by individuals who are black Americans, Hispanic Americans, or Native Americans, or who are economically or socially disadvantaged (including women)?	No funds will be set aside for this purpose, since AID waives its procurement regulations, as per HB13, Ch.5 and HB 1 Suppl. B, for grants to international organizations.
l.	FAA Sec. 118(c). Does the assistance comply with the environmental procedures set forth in A.I.D. Regulation 16? Does the assistance place a high priority on conservation and sustainable management of tropical forests? Specifically, does the assistance, to the fullest extent feasible: (a) stress the importance of conserving and sustainably managing forest resources; (b) support activities which offer employment and income alternatives to those who otherwise would cause destruction and loss of forests, and help countries identify and implement alternatives to colonizing forested areas; (c) support training programs, educational efforts, and the establishment or strengthening of institutions to improve forest management; (d) help end destructive slash-and-burn agriculture by supporting stable and productive farming practices; (e) help conserve forests which have not yet been degraded by helping to increase production on lands already cleared	Assistance complies with AID REgulation 16. Forestry activities are not part of the project. However, the effective control of locust will have an indirect result in preserving Sudan's vegetation.

or degraded; (f) conserve forested watersheds and rehabilitate those which have been deforested; (g) support training, research, and other actions which lead to sustainable and more environmentally sound practices for timber harvesting, removal, and processing; (h) support research to expand knowledge of tropical forests and identify alternatives which will prevent forest destruction, loss, or degradation; (i) conserve biological diversity in forest areas by supporting efforts to identify, establish, and maintain a representative network of protected tropical forest ecosystems on a worldwide basis, by making the establishment of protected areas a condition of support for activities involving forest clearance or degradation, and by helping to identify tropical forest ecosystems and species in need of protection and establish and maintain appropriate protected areas; (j) seek to increase the awareness of U.S. government agencies and other donors of the immediate and long-term value of tropical forests; and (k) utilize the resources and abilities of all relevant U.S. government agencies?

m. FAA Sec. 118(c)(13). If the assistance will support a program or project significantly affecting tropical forests (including projects involving the planting of exotic plant species), will the program or project (a) be based upon careful analysis of the alternatives available to achieve the best sustainable use of the land, and (b) take full account of the environmental impacts of the proposed activities on biological diversity? N/A

n. FAA Sec. 118(c)(14). Will assistance be used for (a) the procurement or use of logging equipment, unless an environmental assessment indicates that all timber harvesting operations involved will be conducted in an environmentally sound manner and that the proposed activity will produce positive economic benefits and sustainable forest management systems; or (b) actions which will significantly degrade national parks or similar protected areas which contain tropical forests, or introduce exotic plants or animals into such areas? N/A

o. FAA Sec. 118(c)(15). Will assistance be used for (a) activities which would result in the conversion of forest lands to the rearing of livestock; (b) the construction, upgrading, or maintenance of roads (including temporary haul roads for logging or other extractive industries) which pass through relatively undegraded forest lands; (c) the colonization of forest lands; or (d) the construction of dams or other water control structures which flood relatively undegraded forest lands, unless with respect to each such activity an environmental assessment indicates that the activity will contribute significantly and directly to improving the livelihood of the rural poor and will be conducted in an environmentally sound manner which supports sustainable development? NO

p. FY 1988 Continuing Resolution If assistance will come from the Sub-Saharan Africa DA account, is it (a) to be used to help the poor majority in Sub-Saharan Africa through a process of long-term development and economic growth that is equitable, participatory, environmentally sustainable, and self-reliant; (b) being provided in

The goal of the project is to contribute to increased food security through the effective control of locust and grasshopper investations. Major locust and grasshopper infestations have the potential for widespread devastation of Sudan's agricultur crops as well as other vegetation The project, developed jointly

accordance with the policies contained in section 102 of the FAA; (c) being provided, when conistent with the objectives of such assistance, through African, United States and other PVOs that have demonstrated effectiveness in the promotion of local grassroots activities on behalf of long-term development in Sub-Saharan Africa; (d) being used to help overcome shorter-term constraints to long-term development, to promote reform of sectoral economic policies, to support the critical sector priorities of agricultural production and natural resources, health, voluntary family planning services, education, and income generating opportunities, to bring about appropriate sectoral restructuring of the Sub-Saharan African economies, to support reform in public administration and finances and to establish a favorable environment for individual enterprise and self-sustaining development, and to take into account, in assisted policy reforms, the need to protect vulnerable groups; (e) being used to increase agricultural production in ways that protect and restore the natural resource base, especially food production, to maintain and improve basic transportation and communication networks, to maintain and restore the natural resource base in ways that increase agricultural production, to improve health conditions with special emphasis on meeting the health needs of mothers and children, including the establishment of self-sustaining primary health care systems that give priority to preventive care, to provide increased access to voluntary family planning services, to improve basic literacy and mathematics especially to those outside the formal educational system and to improve primary education, and to develop income-generating opportunities for the unemployed and underemployed in urban and rural areas?

by donors and the GOS, is sustainable in that it rationally builds on the resources of the GOS. It will help to maintain Sudan's natural resource by averting the potential damage caused by locust and by utilizing environmentally sound methods of control.

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ANNEX D

FINANCIAL/ECONOMIC FEASIBILITY

1.0 Objective

2.0 Methodology

3.0 Basic Scenario

4.0 Additional Scenarios Under Various Assumptions

5.0 Most Likely Scenario

6.0 Regional Considerations

7.0 Recurrent Cost Analysis

ANNEX D
FINANCIAL / ECONOMIC FEASIBILITY

1.0 Objective

The objective of this annex is to demonstrate the cost effectiveness of the proposed locust control activities in Sudan.

2.0 Methodology

Basically, the approach of this exercise is to compare anticipated benefits and costs of locust control to determine financial/economic returns. Firm data is scarce, so estimates must be made on the best information available.

This analysis is primarily concerned with desert locusts which are perceived as an immediate threat on a large scale. Costs and benefits to control of other types of locusts (tree locust, African Migratory Locust, etc.) would be small in comparison, normally within the margin of error of this analysis. Grasshopper control involves a different strategy (a plant protection approach rather than a military-style campaign) and is not expected to be a major activity for the Locust Control Unit. It is anticipated that a contract will be let to determine threshold levels of infestation at which grasshopper control should be undertaken.

Estimates of benefits to locust control are obtained by placing a monetary value on the crops which can be saved by locust control. Crop area, yield and price data are obtained from published statistics. Past observations regarding size of locust swarms, extent of destruction and duration of attack allows area threatened to be estimated. Past experience with locust control permits the estimation of the portion of the area threatened which can be saved from damage or destruction. The value of crops in this portion of the area threatened is then calculated.

Costs of locust control are derived from budgets in the multi-donor program headed by FAO for medium term locust control in Sudan.

Corresponding benefits and costs are arrayed over a ten year period in order to allow consideration of the time value of money (measured as Internal Rate of Return) as well as gross and net returns to locust

control.

Due to the paucity of data and the impossibility of predicting future events and conditions with accuracy, the following analysis will be presented as a series of scenarios based on varying assumptions. The most important assumptions are those regarding level of locust attack (light, medium and heavy) and effectiveness of control (30%, 50% and 70%). These alone could result in nine scenarios, and there are other assumptions regarding future costs and values which could result in a hundred or more separate scenarios. Therefore, only two scenarios, a basic scenario and one based on expected developments will be presented in detail. The other scenarios will be shown in graphic form as relationships between IRR and varying levels of attack (infestation), effectiveness of control, costs or benefits. As the program progresses, financial re-evaluation can be conducted on the basis of new information as it arises, simply by selecting the most likely scenario as it appears in the graphic form, or by adjusting an existing scenario to fit the circumstances.

Estimates of crop damage in Sudan under different degrees of locust infestation are possible.

- Sudan has about 2 million square kilometers of land area open to attack from desert locust.

- A heavy infestation could threaten 150,000 to 300,000 km^2 per season, or even more. (Say 2500 km^2 per day for 100 days, or 12.5% of the area in Sudan open to attack.
- A medium infestation could threaten 50000 to 150000 km^2 per season (say 100000 km^2 or 5% of the area).
- A light infestation could threaten 10,000 to 50,000 km^2 (say 30,000 km^2 or 1.5% of the area.

Since locust attacks are considered to be random, the above percentages can be used to determine areas of crops threatened by locust attack.

Data from agricultural statistics published by the Sudanese Ministry of Agriculture and Natural * Resources (MOANR) indicate that the five basic food crops (sorghum, millet, wheat, groundnuts and sesame) make up about 90% of the cropped area in Sudan and account for about 80% of the value of all crops. Also, these five crops are most susceptible to locust damage. Areas and values of these crops are shown below.

The above figures, although approximate and of uncertain relation to the future, provide the required basic estimates of crop area threatened and value of these crops. Various sources of information were

	area 000 feddans	value L per feddan[1]
sorghum	12,000	166
millet	4,000	62
wheat	300	556
groundnuts	1,500	353
sesame	3,000	202

[1] Calculated on the basis of local market prices where possible. International market prices were used for wheat.

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* - Current agricultural statistics vol.1, No.4, 1984.
  - Yearbook of agricultural statistics, 1984
  - Provincial shares and instability of food crop production in Sudan PS-RR-3 1987.
  - Agricultural situation an outlook vol.iv, No. 6, 1987
  - Sudan crop situation and outlook for 1987/1988.

consulted in search of a reasonable crop valuation for this analysis. The valuation is largely subjective for several reasons:
1. It represents a future situation which is unknown.
2. Area, yields and production vary greatly from year to year. The following differences in total food crop production are illustrative:

	1986/87	1987/88	% CHANGE
area (000000 feddan)	19293	15223	-21%
production (000000MT)	4314	2378	-45%

3. Prices are even more elusive and variable. Local market price, except for wheat, were considered as most reasonable for valuation. Prices vary 100% or more at the same time by market location (usually higher in the west). Markets examined were Gedaref, Um Ruwaba, El Obeid, Kadugli and El Fasher. Prices also vary 100% or more by season.

Value of food crops is a function of area, yield and price, all of which vary. The crop valuation shown above could vary as a result of change in either or all. A special chart (Fig. 4) has been included to show how variations in crop value affect financial returns.

Sudan produces about 3.5 billion Sudanese pounds worth of food crops per year on an area of 20.8 million feddans (about 8.5 million hectares or 85,000 km^2). This converts to $350,000,000 at the rate of L10 = $1 which is considered more realistic than the official rate for this type of analysis.

If we apply the above estimate of total area threatened to the cropped area (and by association, to the value of these crops) we obtain the following values for crops threatened by light, medium and heavy locust attacks.

Light	$350,000,000	x 0.015	= $5,250,000.
Medium	$350,000,000	x 0.05	= $17,500,000.
Heavy	$350,000,000	x 0.125	= $43,750,000.

The next step is to calculate benefits to locust control by determining the value of crops which can be saved under differing levels of effectiveness. This is shown below in millions of dollars. (Multiply value of crops, above, by percent control).

	30% CONTROL	50% CONTROL	70% CONTROL
Light	1.6	2.5	3.5
Medium	5.3	9.0	12.4
Heavy	13.3	22.0	31.0

On this basis a schedule of benefits, for Sudan alone, has been constructed for financial analysis. This schedule of benefits does not take into account the benefits which could accrue to Sudan and the entire region from averting a locust plague. These benefits will be discussed elsewhere.

Note that no benefits are expected to accrue to the project in year 1 (1988), and that benefits reach their upper limit only by year 4. This is logical considering the start-up time of projects of this sort, and on the assumption that efficiency increases with experience.

Costs of Locust Control are taken from FAO/GOS

BENEFITS FROM LOCUST CONTROL (000,000 US$)

	DEGREE OF INFESTATION								
	LIGHT			MEDIUM			HEAVY		
	% CONTROL			% CONTROL			% CONTROL		
YEAR	30	50	70	30	50	70	30	50	70
1	-	-	-	-	-	-	-	-	-
2	0.6	1.0	1.5	2.0	4.0	5.0	5.0	10	15
3	1.2	2.0	3.0	4.0	6.0	10.0	9.0	15	25
4	1.6	2.5	3.5	5.3	9.0	12.4	13.3	22	31
5	1.6	2.5	3.5	5.3	9.0	12.4	13.3	22	31
6	1.6	2.5	3.5	5.3	9.0	12.4	13.3	22	31
7	1.6	2.5	3.5	5.3	9.0	12.4	13.3	22	31
8	1.6	2.5	3.5	5.3	9.0	12.4	13.3	22	31
9	1.6	2.5	3.5	5.3	9.0	12.4	13.3	22	31
10	1.6	2.5	3.5	5.3	9.0	12.4	13.3	22	31

Cooperative Program - Plan of Operation for years 1-3 (project years). Recurrent costs for years 6-10 have been estimated on the basis of the programmed GOS contribution shown in the above cited FAO/GOS Plan of Operation and projected costs for vehicle and equipment replacement, etc. These are shown in column 2, below. (Core project only; costs of pesticide disposal, stores improvement and storehouse procedures upgrading not included). Cost schedules for light and heavy infestations are shown in columns 1 and 3.

COST SCHEDULE (000,000 US$)

YEAR	LIGHT INFESTATION (1)	MEDIUM INFESTATION (2)	HEAVY INFESTATION (3)
1	1.7	2.3	4.6
2	1.6	2.2	4.4
3	1.4	1.9	3.8
4	0.9	1.2	2.4
5	0.8	1.0	2.0
6	0.8	1.0	2.0
7	0.8	1.0	2.0
8	0.8	1.0	2.0
9	0.8	1.0	2.0
10	0.8	1.0	2.0

3.0 Basic Scenario

It is possible to calculate financial returns from the foregoing schedules of benefits and costs. These schedules represent future benefits and future costs, impossible to predict with certainty and all based on assumptions. The most important assumptions for financial analysis are as follows:

Level of Infestation - called light, medium and heavy, corresponds roughly to the stages of recession, upsurge and plague in the jargon of locust fighters. Both costs and potential benefits vary with level of infestation, as noted in the foregoing schedules.

Effectiveness of Control - three levels are utilized: 30%, 50% and 70% of area threatened by locusts to be saved by control efforts. The basic scenario uses the 50% level of control.

Value of Crops - this figure is based on recent and current statistics, but could vary considerably in the future depending on weather, political realities and other conditions. Five value regimes are utilized for the following analysis. The basic scenario utilizes crop values as determined from published statistics. Other scenarios utilize values expressed as percentages of the base estimate.

Costs of Control Efforts - Budgets for the Locust Control Project, on which the cost schedules are based, assume a certain level of effort in response to some median locust threat. Obviously, costs will vary by level of activity which in turn varies by level of infestation. Therefore, it is necessary to assume three levels of costs to coincide with each of the three levels of infestation.

The basic scenario assumes medium infestation, 50% control, and the base estimate of value of crops and costs in line with the medium infestation.

The basic scenario indicates that 73 million dollars in crop damage are avoided with an investment of 13.6 million over a ten year period. This is an average gross savings to Sudan of 7.3 million dollars per year or a net savings of about 6 million dollars. Discounted returns analysis shows an internal rate of return (IRR) of 146% - very impressive indeed from the standpoint of commercial investment and even more so compared to most international assistance programs.

BASIC SCENARIO 1 (000,000 US$)

ASSUMPTIONS LEVEL OF ATTACK	EFFICIENCY OF CONTROL	YEAR	COSTS	BENEFITS	CASH FLOW
Medium	50%	1	2.3	-	-2.3
Medium	50%	2	2.2	4.0	1.8
Medium	50%	3	1.9	6.0	4.1
Medium	50%	4	1.2	9.0	7.8
Medium	50%	5	1.0	9.0	8.0
Medium	50%	6	1.0	9.0	8.0
Medium	50%	7	1.0	9.0	8.0
Medium	50%	8	1.0	9.0	8.0
Medium	50%	9	1.0	9.0	8.0
Medium	50%	10	1.0	9.0	8.0
TOTAL			13.6	73.0	59.4
IRR-%					146
Average Benefits - Gross					7.3
- Net					5.9

Although IRR analysis is not completely appropriate for evaluating the locust control project, it is a useful tool for comparison of the various scenarios to be presented.

A positive IRR greater than the vaguely defined "value" or "opportunity cost" of capital is generally taken to indicate that a proposed investment is sound. This would probably be in the neighborhood of 15 or 20 percent above the inflation rate for Sudan.

If costs of pesticide disposal, stores upgrading and storehouse procedures improvement were considered in the basic scenario, the IRR would still be a respectable 87% and net yearly savings would be over 5 million dollars.

4.0 Additional Scenarios Under Different Assumptions

Better information may come to light as the Locust Control Project gets under way. For example, it may soon become apparent that costs have been overestimated, or underestimated. The question "What if costs have been underestimated by x percent?" can be answered at a glance from Figure 1. (Internal Rate of Return will drop from 145 to 125 if costs were underestimated by 15%, etc.). Figure 1 is actually a graphic representation of several scenarios.

Figure 2 shows IRR at different levels of locust infestation under three sets of assumptions regarding effectiveness of control efforts. What if the infestation is very light (15,000 km^2 threatened) and control measures are only 30% effective? Answer - IRR becomes zero or negative - the program is not cost effective in terms of crops saved in Sudan. It must be emphasized strongly at this point that LCU activities in times of recession are aimed at avoiding locust infestations. Value of infestation avoided will be discussed elsewhere.

Figure 3 shows how IRR varies with effectiveness of control at three discrete levels of infestation. The internal rate of return to efficient control of an infestation of plague proportions would be astronomical - about 300 percent if area threatened were 250,000 km^2 and control were 70% effective. In this case, savings in crop loss over a ten year period would be in the order of 260 million dollars and average yearly net savings would be about 23 million dollars.

Value of crops threatened and saved by control efforts can reasonably be expected to vary over time because of changes in price, area cropped, yield, etc. Figure 4 shows the interaction of IRR and crop value, other things being equal. For example, if crop value

rises 25% from the level of our basic scenario, IRR will increase from 150 to 195. Put another way, if crop value has been overestimated by 25%, IRR would be about 105 rather than 150.

5.0 Most Likely Scenario

Scenario 2 is considered to be realistic and slightly conservative. There is reason to believe that locust activity will increase in the next few years, hence the variation in the first column of assumptions. It is reasonable to expect locust control to become more efficient because of the multi-donor project and to become more efficient with experience (see second column). There is also reason to believe that the costs of locust control have been somewhat underestimated, especially for years six through ten in years of medium and heavy activity.

Gross and net savings are somewhat less than those of the Basic Scenario 1, but IRR is slightly higher. It follows that the Locust Control Project will result in an overall savings of crop loss of about 59 million dollars over the next ten years, an average net annual savings of about 3.8 million dollars and an IRR of 155%.

6.0 The Regional Considerations

Crop losses avoided by locust control may be more important than the benefits discussed above. The objective of LCU activities in times of recession and upsurge is averting a locust plague. This requires the Cooperation of all countries concerned, and all countries benefit from a concerted, successful regional control effort. Benefits cannot be estimated on a regional basis with the data at hand. Social or humanitarian benefits are not the subject of this analysis, but they would undoubtedly be substantial in terms of avoiding hunger, social upheaval, demographic displacement, etc. and in averting inefficient emergency food relief programs. However, it is only fair to point out that even serious locust infestations would probably cause less social and economic problems than a regional drought, which typically reduces food supply by twenty percent or more in the Sahelian area. Furthermore, droughts and heavy locust infestations are not compatible, they are unlikely to occur simultaneously.

SCENARIO 2 (000,000 US$)

ASSUMPTIONS LEVEL OF ATTACK	EFFICIENCY OF CONTROL	YEAR	COSTS	BENEFITS	CASH FLOW
Medium	30%	1	2.3	-	-2.3
Heavy	30%	2	4.4	5.0	0.6
Heavy	30%	3	4.2	9.0	4.8
Heavy	50%	4	4.0	22.0	18.0
Medium	50%	5	1.7	9.0	7.3
Medium	50%	6	1.7	9.0	7.3
Light	50%	7	0.7	2.5	1.8
Light	50%	8	0.7	2.5	1.8
None	-	9	0.7	-0-	-0.7
None	-	10	0.7	-0-	-0.7
TOTAL			21.1	59.0	37.9
IRR-%					155.34
Average Benefits - Gross					5.9
- Net					3.8

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7.0 Recurrent Costs

The Government of Sudan (GOS) will have to shoulder the costs of locust control after mid-1991, according to projections of budget for the current project. These costs are not additional costs due to the Medium Term Locust Control Project. They have been reflected in the past as part of Chapters I and II budgets of the PPD. According to Hassan Abbas El Tom, the GOS spent more than 2.3 million pounds (the estimated amount of recurrent costs) for locust control in 1986/1987.

The following budget is for core activity costs which are expected to occur in the absence of a locust threat (during periods of recession). Those activities would be primarily survey and monitoring, reporting and control of scattered concentrations of locusts and grasshoppers. The GOS cannot be expected to finance additional costs occasioned by locust upsurge or plague. They will be dependent on external sources for all such costs.

Salaries and allowances have been calculated on the basis of official GOS salary levels for a minimal staff of the Locust Control Unit within the Locust and Grasshopper Section of the PPD. Although these salaries may be augmented, the assumption is that this would be done during locust campaigns only, and would be covered by donated funds.

A minimum amount of pesticides will be necessary during recession. The assumption for the recurrent budget is for 15 metric tons of Fenitrothion 96 ULV and one ton of Fenitrothion equivalent emulsifiable concentrate for ground control. This should be enough to treat about 50,000 feddans, almost all to be applied by portable ground sprayers. Fenitrothion costs about ten thousand dollars per MT and will have to be paid for with foreign exchange. It is included in this budget even though it can be realistically assumed that at least part of the pesticide will be donated.

Core activities during recession will require aircraft use for survey (reconnaissance) and for a minimum amount of spraying. For this budget, we assume the aircraft will be hired (chartered) on an as needed basis, probably for two surveys per year, each requiring about 50 hours of flying time. The additional 20 hours may be needed for special reconnaissance and/or control. Costs are estimated to be LS4000 per flying hour.

Fuel costs for LCU vehicles are estimated on the basis of 15 gallons per day for 30 vehicles for 130 days per year. Fuel cost is L4 per gallon.

Maintenance costs are estimated on the basis of ten percent (per year) of the value of the inventory of vehicles and equipment which is about $570,000 for

vehicles and $80,000 for equipment, or L3,000,000.

The LCU will need to maintain a reserve pool of trained field technicians, in addition to their own personnel, who can be seconded in years of emergence or plague. In addition, they should provide refresher training for their own technical personnel. Almost all of this training will have to be provided in the month of May when there is a break in field activities. The L90,000 budget figure covers costs for didactic material, visual aids, classroom costs, outside trainer honoraria, etc.

Replacement costs for vehicles and equipment are not included in the budget for recurrent costs as it is assumed they will be provided by donors. About ten vehicles per year and up to L200,000 in equipment would have to be replaced. This cost would be about a million pounds per year.

Other costs are for transport, clearing, handling office supplies, contingencies, etc.

As mentioned above, the recurrent budget is for the Locust Control Unit after the project terminates, assuming only recession activities. If in fact locust control activities persist beyond the life of the project, GOS would be obliged to increase their budget by about 12 percent for a medium infestation or 23 percent in case of a plague. Most of the additional costs would be paid by donors, the increase in GOS costs would be mostly for salaries and allowances.

ANNUAL RECURRENT COSTS - CORE ACTIVITIES ONLY
RECESSION YEARS

	LS
Salaries and Allowances	
3 Admin. personnel x L 7200/year	21,600
20 Technical personnel x L6600/year	132,000
26 Support personnel x L5340/year	138,840
TOTAL	292,440
Pesticides	
ULV (Fenitrothion 96%) 15MT x L45,000	675,000
EC (as above or equivalent) 1MT x L45,000	45,000
Aircraft Hire	
120 hours x 4,000/hr.	480,000
Diesel	234,000
Vehicle and Equipment Maintenance	300,000
Training	90,000
Other	150,000
TOTAL	2,266,440

ANNUAL RECURRENT BUDGET, (LS.000)
IN TIMES OF RECESSION, UPSURGE AND PLAGUE

	RECESSION	UPSURGE	PLAGUE
Area Treated : feddans	70,000	300,000	1,000,000
Salaries and Allowances	293	424	563
Pesticides	720	720	720
Aircraft Hire	480	480	480
Diesel	234	234	234
Training	90	120	150
Vehicle and Equipt. Maintenance	300	350	400
Other	150	200	250
TOTAL	2267	2528	2797

Annex E

TECHNICAL ANALYSIS

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ANNEX 2

TECHNICAL ANALYSIS

1.0 Introduction

The Core Locust Control component of the Medium Term Locust Control Project will provide structural and operational guidelines for the newly created Locust Control Unit. This technical analysis reviews the structure and guidelines as they pertain to an efficaceous locust and grasshopper control program. The Unit's primary function will be to carry out all locust surveys, conduct ground control at times of minor activity, and direct and supervise ground and aerial locust control in periods of greater activity. In addition, the Unit will attempt to accomplish other tasks such as develop and test new ground control methods, establish threshold levels for grasshopper infestations, improve local information services, and train regional staff in case they are needed during a major locust campaign. This technical analysis examines the project and gives guidelines and recommendations for effective implementation.

2.0 Survey, Reporting and Information

In locust control, which is a pseudo military operation, the gathering of information, and its rapid transfer and analysis is vital. The analysis must be presented to decision makers both at the operational control level and at the higher level where major decisions must be made.

2.1 Ground Survey and Reporting

The basic method of survey is by vehicle. Ideally the survey officer should make regular sampling stops and note the state of the habitat. This becomes more important during recessions, when the prediction of an upsurge could be an invaluable tool. In practice a standard method of sampling is less important than

rapid transfer of information.

Information obtained from local residents can be extremely important even though anecdotal and somewhat imprecise, however this source of information must be actively sought. An SSB radio in all survey vehicles, field stations and Khartoum headquarters is a requirement. In the past, there has been a resistance to the introduction of vehicle radios. The present system where an officer must return to base before his report is sent, by radio, to Khartoum is completely unsatisfactory. The report is often received weeks after the sighting and usually lacks details which may be vital. These details might well be available and clarified if the officer in Khartoum could talk to the officer who made the survey.

2.2 Aerial Survey

The first use of an aerial survey is to look for green vegetation areas where breeding may be occurring. Ground teams can then be dispatched to investigate.

During outbreaks and plagues aircraft can be used to look for bands which can show as a yellow 'stain. Bands will not be visible if the vegetation is dense. This is important for aerial spraying since it is difficult to delimit blocks containing a worthwhile area of band by ground survey. Flying swarms can be detected by air, sometimes from as far as 50 km away. Roosting swarms can also be seen but only from a distance of a few km.

There is, in general, limited advantage to using helicopters for survey. Helicopters are expensive, difficult to maintain, slow and have poor endurance. Helicopters can be of great value, however, in tracking low flying swarms in very rugged country. They also have the advantage of being able to land virtually anywhere in order to investigate a situation.

2.3 Advanced Technology

2.3.1 Radar.

Individual insects can be located with a suitable radar but that is purely a research tool. Swarms can be detected at substantial distances by normal weather radar and probably identified as such, however, erecting a chain of radar for swarm detection is not economically or logistically feasible.

2.3.2 Light Traps.

These are most useful during recessions when a catch can give early evidence of an upsurge of a movement. It is however, very difficult to maintain traps in a functioning state and ensure that the operator carries out his job.

2.3.3 Remote Sensing.

The potential use of remote sensing is in detecting areas, of green vegetation, where breeding might be taking place. Bands and swarms cannot be detected by any of the non-military satellites. There are several sources of this type of information currently available. METEOSAT, which can be used to produce a 'rainfall' map from cloud top temperature analysis and NOAA which can be used to produce a 'greenness' estimate from ground reflected and emitted radiation. LANDSAT is essentially similar to NOAA but is more precise, less frequent and much more expensive. It must be appreciated that these are not direct ways of measurement. The internal validity of both must be tested against 'ground truth'. Remote sensing is likely to be most useful when both products are used in combination with rainfall figures and conventional synoptic analysis.

2.4 Evaluation and Information

There is little point in gathering information if it is not analyzed and used. The Locust and Grasshopper Section of the PPD, in Khartoum, has the appropriate facility and its operation is being developed with the assistance of an FAO office assigned to Sudan for a year.

Incoming information needs to be plotted and evaluated on a daily basis regardless of developments. A key element in evaluation is weather, especially rainfall. This should be checked daily at the weather forecasting office so that the Information Officer can discuss with the Duty Forecaster probabilities and likely developments from the locust standpoint. The evaluation will provide a basis for advice to the head of the Locust and Grasshopper Unit. From this information, there should be a well presented monthly bulletin in a form comprehensible to non-technical

people. This should go to the Minister, donors and possibly to the media.

The use of remote sensing products is debatable. As has been pointed out, their use is in the development stage and they are likely to prove most valuable in conjunction with conventional weather analysis. There is also the matter of cost and of getting the product to Sudan quickly enough to be of use. FAO should be able to carry out the analysis and inform Sudan of the findings, but at the moment, FAO does not have the necessary resources.

It is tempting to think that the general public can be a source of information but that is only true to a limited extent. An inexperienced observer can be relied on to recognize swarms or bands. The situations in which the public would, in theory, be most useful are at the first stages of an upsurge. Even then some skill is required for identification. People, however, cannot be expected to be on the alert over periods of years. The most valuable information, and it can be very valuable, comes from farmers and pastoralists. This must be sought during survey, it will normally not be volunteered if a journey of many days is required to make a report. It may be possible to build up a network of people interested in natural history and who can be instructed in what to look for. The 'Desert Locust Recognition Handbook' would be useful to such people and indeed to officials not primarily concerned with locusts.

2.5 International Information Analysis

Locust developments outside Sudan are as important to the country as developments within its borders, and the same principle holds for other countries. Thus, Sudan needs information about the current situation and developments elsewhere. This is supplied through the FAO's Desert Locust Information Service (DLIS), located in Rome. FAO relies on information supplied by individual countries, therefore Sudan has an obligation to send information rapidly to Rome. At present, the system is not functioning well, a deficiency in one part tends to lead to deficiencies elsewhere. For example, countries will not take pains to send information to Rome if they believe DLIS makes poor use of the information. Due to the slowness of information transfer, DLIS has to base its analysis and forecasts on sightings made at least three weeks before. In order to assess the current situation one must 'forecast' a month ahead. Information is inadequate and from many large and potentially important areas, non-existent. Information is often

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less than completely accurate, especially in assessing the effect of control campaigns. There have been cases of countries deliberately not reporting important infestations over a period of several months for political reasons. Even allowing for these difficulties DLIS has not provided the information it should have due to the service being grossly understaffed. The service has, until recently, been a part time activity for one experienced officer. It is now a full time activity for one officer with locust experience. DLIS has failed to spot certain key developments during the last three years and has failed at times to encourage and assist countries to investigate suspect areas.

An obvious and simple way to improve the service would be by the standard use of electronic data transfer especially telefax between Rome and, in this case, PPD in Khartoum.

3.0 Control Methods

3.1 Pesticide Application and Choice

The basic method of control now is ultra low volume (ULV) 'drift' spraying using concentrated non-volatile liquids dispersed in small droplets. 'Drift' is an unfortunate term since it conjures up a picture of an uncontrolled spread which is not the case. The risk of off target contamination should be no greater than with relatively high volume spraying of emulsifiable concentrate (EC) mixed with water.

The logistic advantages of ULV application are very great when control must be mounted in remote areas at short notice. ULV spraying requires a lower area volume where the vegetation cover is sparse. Furthermore, a much larger area can be treated in a given time than with conventional (EC) spraying. Dusting and baiting, like conventional spraying, are of limited application because of the logistic problems of transporting considerable quantities of material and maintaining the large labor force required (Table 1). However, more care is needed with ULV spraying than with other methods, both in the conditions of application and with safety, due to their concentrations.

TABLE 1 REQUIREMENTS TO TREAT 50km^2 IN ONE DAY
(estimates approximate especially for baiting)

	AIR ULV	GROUND ULV	GROUND EC[2]	BAITING[3]
Application machines	3.0	40.0	1000.0	-
Vehicles (pickups)	1.0	40.0	250.0	250.0
Trucks (supply)[1]	3.0	3.0	16.0	160.0
Fuel (tonnes)	2.0	1.5	5.0	4.0
Pesticide in form supplied (tonnes)	1.8	1.8	18.0	250.0
Staff	10.0	130.0	1600.0	1300.0

[1] Assumes 1 truck able to supply 1 load of 6 tonnes every 4 days

[2] Assumes 50% EC diluted at 1 part in 4 parts water.

[3] At 1ha/hr.

3.2 Basic Principles of Application

It is necessary to set out the simple physics governing ULV spraying since one or more critical features have been overlooked in most recent spray operations.

3.2.1. Spray Droplets

Large droplets fall rapidly and hence collect on horizontal surfaces; a 100 micron droplet has a terminal velocity of 00.3 m/s. Droplets smaller than 50 microns take several minutes to fall 1 meter, and will travel basically horizontally and so should collect on vertical surfaces. If the majority of the horizontal

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surface is bare ground, most large droplets will be wasted. However, droplets moving horizontally tend to follow the airflow around an object. The larger the object, the more it distorts the windflow. The larger the object and the greater the velocity of the droplet, the greater is the chance of impacting on an object of a given size and shape.

It is clear that for effective ULV control, a steady wind is essential. Collection on sparse rough vegetation is roughly seven times greater in a steady wind above 3m/sec or 7 mph (measured at 2m above the ground) than in a light and variable wind. But it should be realized that wind speeds below the height of even sparse vegetation will always be much less than that of a meter above.

The ideal droplet size varies with the nature of the target and the structure of the vegetation. There is limited data to determine which droplet size to choose although larger droplets (>150 microns) are clearly undesirable in most circumstances. They fall too quickly and contain too much pesticide.

One field trial indicated that droplets of about 100 microns impacted better on well grown cotton than both larger and smaller droplets. Cotton is very different from the vegetation locusts usually infest. Nevertheless, experience suggests this is a sensible size to aim for if the vegetation is the target and will result in a desirable deposit. However, if the aim is to kill by direct impingement, there is a further complication. A droplet larger than 100 microns contains more than a lethal dose of many ULV formulations. Pesticide in smaller droplets will be much more effective than the same amount in one large droplet. Dilute pesticide has been shown to have greater killing power than a more concentrated formulation but the cause of this increase is most certainly the increased number of droplets.

There are sprayers available which will produce a narrow enough droplet spectrum. Research and experience has indicated that droplets larger than 130 microns or smaller than 50 microns should be avoided. Flatfan nozzles produce many very small droplets but a large percentage of the pesticide is in a few oversized droplets. Misting machines generate too large a mixture of sizes of droplets. Of the devices currently available, spinning discs produce the narrowest droplet spectrum followed by spinning cages. Electrostatically produced droplets will have an even narrower droplet spectrum but these sprayers are still in the development stage.

3.2.2. Swath Width

Swath width is not a simple function of wind speed, but also droplet size. Small droplets will be brought close to the target not by gravity but by turbulent mixing of the air close to the ground. In conditions where ULV spraying is utilized, swath width is probably reasonably constant for a given height of emission. As a rough guide, spray emitted by an aircraft flying at 50m above ground will first be deposited about 15m downwind, collection will be at a maximum 50m downwind, and will still be significant at 200m but will have declined to a negligible value by 300m. Increased emission height much increases swath width, although total deposit is not changed greatly. This means that with small targets a low emission height is essential. However when spraying by air the target block should never be less than about $1km^2$.

Flying swarms move through the air, and hence through the spray cloud, at their flying speed, which is approximate 3m/sec. They are very good collectors of droplets. The flying locust will acquire virtually all the droplets in the volume of air which it sweeps out in flight. The requirement for efficient control is that the spray remain in the air in which the locust is moving, for as long as possible; that means using very small droplets which will have negligible fall speed.

3.2.3 Species and Developmental Stage Variation

The application rate of a given pesticide needed to achieve good control of an insect at a particular stage of development can vary greatly between species. It is difficult to correlate the difference in tropical application found in the laboratory to the field. A larger insect will weigh more but it will also collect more. On the other hand, the smaller the insect the larger its surface area relative to its weight, therefore, the smaller insect will be a more efficient collector.

Similarly, different developmental stages require different amounts of pesticide for effective control. Early instar nymphs can be controlled with relatively less pesticide. However, these are seldom a control target because they occur in many small patches which are difficult to find and time consuming to treat. Last instar nymphs are difficult to kill but soft young adults died relatively easily.

The basic principles of droplet behavior are a

matter of elementary physics, but the practical situation is more complex. The form of the collecting surface, and the structure of the wind flow close to the ground, make it difficult to derive a spraying technique from the basic principles.

3.2.4 Research and Development Studies

Droplet behavior is basic for all pesticide application; it would be difficult to justify such research for locust control alone. It would in any case best be carried out by a research institute with an interest in micro and meso scale meteorology. Such research is desperately needed, because of concern about the environmental effects of off target contamination and improved efficacy programs.

Despite the lack of experimental evidence one can be reasonably confident that where vegetation is the target, as much as possible of the emitted pesticide should be in droplets of about 100 microns. A comparison of control of bands sprayed with droplets of 60 and 100 microns of a contact pesticide should be carried out. The comparison should cover a range of environmental conditions since these conditions would be likely to be even more critical with the smaller droplets than with the larger. This is not an activity envisaged in the Sudan Locust and Grasshopper Control Project.

As has been noted, control of swarms in flight may be efficient. The method has operational advantages since swarms are best found by air, when they are flying. Under good conditions a swarm can be seen several tens of km away. An aerial 'search and destroy' operation is relatively easy to mount. There is a need to establish an aerial application system comparable with the area dosage for spraying of settled targets. But it is not obvious how that should be done. As a first step a very experienced aerial locust control expert should be given the chance through treatment in the field to attempt to develop a system. This will be partly intuitive in form and subjective in evaluation. It is not clear whether one should aim to kill both settled and flying insects, or whether one should aim for the fliers only, continuing treatment until all the locusts have become airborne for long enough to collect enough pesticide to kill them. This research is beyond the resources of the Locust and Grasshopper Control Project.

3.2.5 Equipment Currently Available

Only spinning cage and spinning disc devices will give adequate control of droplet size for ULV application, discounting electrostatic sprayers. Micronair rotary atomizers have been the standard recommended equipment for aerial application for many years, however, only recently in developing countries. The difference between the AU4000 and the smaller AU7000 in terms of drop spectrum is unlikely to be significant. Beecomist atomizers use a porous cylinder; they have no obvious advantage over the Micronair.

There is no completely satisfactory ULV vehicle sprayer. The Evers and Walls exhaust-nozzle sprayer has long been used to apply dieldrin with considerable success but we should look for something better. Both lack of ability to control the deposition of the deposition of the insecticide and unnecessary exposure of the operator to exposure to the insecticide dictates the use of more sophisticated equipment.

The Micron Sprayers Microulva is a technically satisfactory and inexpensive hand held device. But the power source of D cell batteries is not the simple solution it appears to be at first sight. The Microulva is more robust than it looks, and it does need to be maintained if it is to give long service.

3.2.6 Future Developments

(a). Air. Micron Sprayers Company has produced an air driven spinning disc device which can be fitted in place of a nozzle. The device will give a narrower drop spectrum than a spinning cage device although we are not yet in a position to make use of this increased precision. An aircraft so equipped could be desirable if attempts are made to devise a system for control of flying swarms.

(b). Ground Vehicle. Both Micron Sprayers Company and Micronair have produced simple ground sprayers. Plans are in place to field test both for reliability, ease of operation and 'custom acceptability'. These include tests in Sudan with a view to standardizing ground ULV vehicle mounted sprayers.

(c). Handheld. The Microulva would seem adequate or more than adequate in every respect except the power supply. That has been realized for some years but no satisfactory solution has been forthcoming.

(d). Electrostatics. Because of the need to discharge by grounding this method is only possible with handheld and perhaps vehicle mounted equipment. It would be desirable to investigate droplet impaction and collection of charged droplets in desert locust habitats: charged droplets might impact better than uncharged droplets in light wind. Such work is not envisaged under the Project but would not require additional resources to carry out. The charged cloud is believed to remain evenly distributed and perhaps coherent, which would be desirable when spraying flying swarms. However, using a ground sprayer against mobile swarms is impracticable.

3.3 Pesticides.

The characteristics of the pesticide influence some aspects of application. Dieldrin, which is a highly persistent pesticide, can be applied in strips as much as 3km apart. Bands in the area will eventually reach a strip, eat the treated vegetation and die. The recommended treatment gives a mean area dosage over the whole treated sector of only 2g ai/ha. It must be noted, however, that due to its persistence in the environment and its extreme toxicity that Dieldrin is no longer a viable alternative and will not be used in the Sudan Medium Term Project. Fenitrothion, which will probably be the insecticide of choice, has some persistence. It has a half life in a hot climate of about two days and acts relatively slowly. Insects in an area treated as recommended do not start to die until an hour or so after spraying and continue to die over the next couple of days. Nymphs acquire the pesticide mainly by secondary means rather than by direct impingement. It is best suited to the treatment of relatively large blocks containing many bands where the band is unlikely to reach the edge of the sprayed area in a days march. Fenitrothion has been tested adequately against C.terrninifera and good control achieved consistently with technical material applied at 400g ai/ha; this has now been reduced to 260g ai/ha with completely acceptable results. An application rate of 450g ai/ha is currently recommended for desert locust band control and this is almost certainly quite sufficient if the pesticide is applied properly.

A considerable number of field trials in Africa of a large number of insecticides has been carried out over the last three years. The insecticides involved are all known to have activity against locust and grasshoppers. The trials suffer from a conceptual error. In most cases several pesticides have been tested with the implied assumption that the one which

achieves the highest proportional kill is to be preferred. The correct intention should have been to find a dosage for each pesticide which would give acceptable control. Efficacy evaluations of these trials is complicated.

An accurate estimation of percent control is very difficult and the methods used have been those proven in the past for grasshopper research. But it is difficult to see what better could have been done. The methods such as transect flush counting are, however, adequate if the aim is to discover whether virtually complete control has been achieved.

Field tests of alternative pesticides are envisaged under the Medium Term Locust and Grasshopper Control Project. These are likely to take the form of a monitored control application rather than a special trial. These trials would therefore add data from operational spraying to the existing research data. This should be quite adequate provided the few critical parameters are either measured or controlled. The Project might also assist with more precise trials carried out by others. If outside institutes are to carry out trials they must have a means of mounting trials at very short notice as and when suitable populations occur.

3.3.1 Aerial

For any aerial control dependent on ground search to find the target, radio contact between the search team and the airstrip is essential. When spraying is being directed from the ground there must similarly be a radio link. In the first case SSB HF is needed and in the second VHF.

Hopper Bands

As has been pointed out only relatively large blocks greater than 1km^2 can be sprayed accurately by air. The problem lies in delimiting blocks. Currently much treatment is carried out on a subjective basis with only minor checks either of effectiveness or of infestation level. This is an extremely difficult problem but clearly some objective basis is needed to decide on the limits of the area to be treated and the infestation level within the block. It is likely that the usual basis is that some naturally defined area, such as a wadi is said to be "full of bands". Although this is not the ideal method for determining spray

boundaries, during an upsurge it may be our only currently usable alternative.

Application should be confined to steady winds in the range of 3m/s. Treatment is dependent on emission rate and swath spacing. There is evidence to suggest that often the recommended rate is assumed to have been applied. And from this, the area treated is derived and the total pesticide used is accounted for. Swath spacing should, where possible, be marked on the ground although an experienced pilot can judge a desired swath interval, at least up to 100m, with surprising accuracy.

Roosting and Settled Swarms

Roosting swarms can often be spotted from the air before they depart although not from a great distance. Roosting swarms occupy a much smaller surface area than do flying swarms, so it is advantageous to treat them in this state. If the locusts are milling before departure, very good kills should be possible. Swarms which are settled through cold can be treated like bands with good results, but such will not be the case in Sudan. Fledglings still attached to bands will, of course, be controlled if the bands are treated.

Flying Swarms

Flying swarms were sprayed in Sudan with success during 1987. The best approach is a survey and control operation, in one, so that swarms spotted can be sprayed at once. This method has advantages. It is easy to conduct and should be economical in pesticide use even though it is difficult to either prescribe or control application rates. Application rate is an almost meaningless concept since it is a volume moving with respect to the ground that is being treated. Low flying swarms can be covered much as a settled target but high flying swarms are best treated by spraying repeatedly over the highest part of the swarm. There are certain risks. The windscreen can become obscured by locusts which smash against it and air coolers can become blocked leading to engine overheating.

3.3.2 Ground Control

The Micronair vehicle mounted rig is the only technically satisfactory ground sprayer available in Sudan. It has been used with success but it is over complicated and not durable. A much simpler, more durable version and also a disc sprayer which should prove equally satisfactory from Micron Sprayers, are on order from Sudan. These should have a swath width of 30-50m and so be able to be used to treat relatively small as well as large areas.

Roosting swarms can be sprayed with ground machinery but not swarms in flight. The problem with the roosting swarm is to locate the site and get machinery and pesticide to that site in time to spray before the swarm departs.

There is a large quantity of hand sprayers in Sudan, these have been provided over the last three years. Most of the knapsack sprayers can be used, especially to treat small targets but application rates are difficult to determine since much of the pesticide is emitted in wastefully large droplets. A large stock of Microulvas exist which would be useful to treat small targets. The supply of batteries presents a problem, however, mainly because they are a highly desirable item, therefore difficult to maintain stock control.

There is a need to review and rationalize the stock of ground sprayers and to service those that are useful. For locust control almost certainly one or both of the new vehicle mounted ULV sprayers should be adapted as standard and a limited supply only of a preferred knapsack sprayer held in reserve for 'spot' spraying of 'patches' of hoppers. Arguments about whether aerial or ground application is to be preferred are academic. In practice all are needed since complete control at the hopper stage is very rarely achieved. However, a decision about the emphasis to be placed on ground spraying of individual bands compared with blocks, influences the choice of pesticide and the organization of a campaign.

The ground survey and control unit is an attractive concept; the search team treats any worthwhile infestation which it discovers. For control of a marching band, fenitrothion is too slow acting to be the ideal pesticide. A mixture of a synthetic pyrethroid, which has a rapid disorienting effect, and fenitrothion might well be highly effective. Preliminary trials of the mixture against brown locust bands, which move very quickly, suggest that it is. The new vehicle mounted sprayers may prove well adapted to this use since enough pesticide for a full days spraying can be carried in the spray tank.

4.0 Supply of Equipment and Commodities

4.1 Aircraft

The aircraft requirement for survey, and still more for control, varies greatly between years. Even when a campaign is underway, extra aircraft can be needed at short notice.

Sudan is a member of DLCOEA whose chief function is to assist members with aerial survey and control. The DLCOEA currently has 12 aircraft. Previously, only the 2 Britten Norman twin engined Islanders have been made available to Sudan. These are the most suitable aircraft, both are well maintained and very well equipped. In the past, the aircraft have not been available on demand. Also, the GOS regulations result in a considerable delay after the aircraft arrives in Sudan before they are cleared for operation. There are no such restrictions and formalities in any other member country of DLCOEA.

The MOANR currently has no operational aircraft of its own, so hired aircraft are needed. The cheapest and most flexible way to provide this is by a 'period contract' which operates for a substantial time - possibly as much as three years. It lays out the rates of hire but does not stipulate how many aircraft will be needed or when. To safeguard the operation minimum number of hours hire and also inflation clauses can be included. Such contracts require a certain amount of fair play and trust on both sides. The hirer must give as much warning as possible of his requirements and the contractor must do all possible to fulfill these requirements quickly. This is recommended to ensure adequate availability of aircraft whenever needed.

It must be emphasized that normal crop spray aircraft should be used for locust control, only as a last resort. Their endurance is usually poor, and their range is too short. They cannot carry an observer and they are usually inadequately equipped with radios.

The requirements for a spray aircraft are:-

1. Micronair rotary atomizers (Au 4000 or Au7000 are equally acceptable).
2. Flow meter and in flight flow regulator.
3. Atomizer RPM counter (optional).
4. At least 300 l pesticide tank.
5. At least 5 hours endurance with 350 kg of pesticide.
6. Rugged construction and bush operating characteristics (STOL aircraft preferred).
7. Ability to carry an observer.
8. Willingness to fit supplied SSB HF radios.
9. VHF air to ground radios.

10.Well maintained.

The requirements for survey aircraft are similar except of course for the spray equipment. Before a contract is let an experienced aircraft engineer should inspect and approve the aircraft and the maintenance facilities.

GOS owns a non-operational Cessna 185. This type of aircraft is good for survey and if fitted with a belly tank (Sorenson) and spray gear, is a adequate spray aircraft. Alternatively it might be possible to fit the self-contained combined spray tank and atomizer wing pods developed by Micronair. The best approach might be to sign a management contract whereby the contractor would maintain this aircraft and supply a pilot at need. Such contracts can, if desired, include hire of the aircraft when not required by the GOS, with part of the hire fee being used to reduce the contract cost.

4.2 Pesticide Supply

This section applies equally to pesticides for locust and grasshopper control. In the past, pesticide has been supplied by donors, some of it not of the preferred type. This reliance creates problems since a request to donors must be made well in advance of need. An interval of six months between request and supply is probably the minimum possible. At least three months may well be necessary between placing an order and its arrival by sea. There can be further delay in clearance. The Steering Committee has been of great value in helping to ensure that adequate supplies of the preferred type of pesticide are ordered. Nevertheless there is always a possibility that insufficient quantities have been ordered. But there is also the possibility of ordering too much. It is impossible to forecast needs with any precision six months ahead.

Storing pesticide in Sudan is difficult and because of the climate, shelf life is short. A solution is to purchase the pesticide, but to have the supplier hold them in store overseas and airfreight them to Sudan when needed. The supplier, with the agreement of the purchaser, could sell from this stock and replace, thus allowing 'turning over' of the stock. There are times when one can be reasonably sure large quantities will not be needed in Sudan within the restocking time, which is normally about 6 weeks. Rates of less than $1.50/kg have been quoted for airfreight to Sudan from Europe. Fenitrothion technical costs roughly $10/kg and on top of that is the cost of shipping by sea. The extra cost of transport by air is not prohibitive.

Pesticide should not be supplied in drums holding more than 100 l. A 200 l drum of fenitrothion technical weighs 280kg. Many have been ruptured when dropped from a truck in an unloading process.

There remains the matter of redistribution within Sudan. This is indubitably difficult since roads are poor and can be impassable after rain. On the other hand, locust incidence and distribution is so unpredictable that there is no feasible way of avoiding the need to move pesticide around the country during the summer. Even with grasshoppers, redistribution is in practice required since stocking sufficient amounts of bait and dust to cope with a severe outbreak in every locality where they might be needed would be very wasteful.

Clearly a compromise is required. It is recommended that some pesticide should be held at key regional centers; immediate reserves should be held at Khartoum; backing reserves should be held overseas.

The overseas reserve could well be a joint reserve for all Africa locust and grasshopper control, organized by FAO. Indeed the Sudan reserve might be used for locust control elsewhere (and replaced at no cost) if the locust and grasshopper situation in Sudan was quiet. FAO is currently investigating the possibilities of this approach and will make a recommendation.

5.0 Training

It is clear, not only in Sudan, but in other North African countries, that many of the officers pressed into service during the current emergency are inadequately trained. There have been reports of poor kill, which are most probably the result of poor application technique. There is little need in Sudan for high level academic training overseas. The majority of the training should take place in-country, utilizing existing FAO and donor resources.

5.1 On the Job Training

The most important requirement is on the job training in survey, reporting and control techniques. This means technical assistance staff (FAO) working alongside PPD staff carrying out these activities in the field.

In addition to on-the-job training, dealing with the technical aspect of locust and grasshopper control,

training in the safe use and handling of insecticides is vitally important. This training must begin at the top levels of the organization and be instilled throughout the ranks to the level of the loaders and handlers. This training will best be accomplished as a cooperative effort between the available Technical Assistance and the Locust and Grasshopper Unit management. The training must emphasize the hazards of both humans and the environment, if unsafe use and poor handling practices are employed. Areas to be emphasized in this training should include the following:

1. Proper loading and unloading of containers.
2. Proper transfer of insecticides from containers to spray equipment.
3. Proper clean-up of any incidental spills.
4. Proper operating, maintenance and clean-up of loading equipment.
5. Proper use of safety equipment and clothing.
6. Proper storage of empty containers.

A continuous monitoring by technical advisors and Unit management will be required to ensure that safe practices continue after the formal training.

5.2 Field Officer Short Course

To reinforce on-the-job training, there is a need for formal short courses, particularly in the techniques and principles of ULV application, and the safe use and handling of insecticides. These can be conducted by existing FAO staff.

5.3 Short Courses for Senior PPD Staff

These should be mainly for Regional Entomologists, in particular to explain their role and responsibilities, and also the basic elements of desert locust survey and control.

5.4 Overseas Training

These should be for officers with responsibility for the operation of a campaign or a section of a campaign. The visits should be to functioning antilocust organizations overseas.

5.5 Training of Seconded Officers

Short courses for selected PPD technicians should be run to train a pool of field officers to be drawn on in times of emergency. A small number of officers from this group should be seconded to the locust unit for a season to gain practical experience.

6.0 Organizational Structure of PPD and Implementation of Locust and Grasshopper Control Project

The organizational structure of PPD is described elsewhere in this report. The key features are the responsibility of the 18 Regional Entomologists for all PPD activities in their Region. These individuals are answerable only to the Director of PPD, and a unified budget for PPD as a whole. This is not consistent with effective locust control, which requires a clear chain of command, rapid response, and a core of well trained officers permanently on the alert. It is however, a sensible organizational structure for all other crop protection activities including grasshopper control.

The creation and operation of the Locust Unit envisaged in the Core Project presents no insuperable technical problems. The staff are available and the lesser duties of the Regional Entomologists' staffs should more than compensate for the loss of one or two officers from each. The total complement of PPD is approximately 4500 (Table 2). The Locust Unit would need less than 50 people including drivers. Sufficient equipment including vehicles, has already been donated for locust control during the last two years under the Emergency or has been allowed for in the Project Plan. Recurrent costs such as fuel and vehicle maintenance for locust survey and control should be no greater than under the present system.

The Locust Unit will operate under a separate budget. This has been established by declaration of the Minister of Agriculture and Natural Resources. The declaration formally created the Locust Control Unit as an autonomous body within the PPD. This is an essential element of accountability .

TABLE 2 STAFF OF PPD Nov. 1987.

Ph.D.	13
M.Sc.	61
B.Sc.	142
Technical Officers (Diploma)	472
Others	3762
Total	4450

Plus many casual laborers

6.1 Campaign Organization

This is the key element in locust control but it is difficult to set out in precise terms. As has been pointed out, locust control is a pseudo military operation. The critical element so far lacking in Sudan, is a clear chain of command and responsibility. This situation has been solved by the structure created in the Locust Control Unit. There must be mutual confidence between headquarters and the field. Those in the field must accept that there are good reasons for decisions which may not be obvious, except from the overall country standpoint. The command at headquarters must rely on the judgment, initiative and efficiency of those in the field. There must be radio communication between headquarters and those in the field. The whole unit must feel involved and responsible for the outcome to be successful. The leader must instill his officers with confidence, enthusiasm and dedication. There is no plan or prescription for doing this. It is however, not possible without the right institutional framework.

It is difficult to organize a successful locust campaign without a nucleus of a permanent locust unit. The degree to which that nucleus can be added to in times of heavy locust infestation is limited. Seconding too many people leads to organizational chaos and ineffective control. However, a small experienced efficient unit with the addition of some previously trained officers, can operate a large and effective campaign.

Since locust control is a pseudo military operation it is tempting to suppose that the army can undertake locust control in times of emergency. This has been tried many times but never with success. An army is too large, too rigid and lacks the technical knowledge and experience.

6.2 Emergency Provision

Once a Locust Unit has been established an emergency should be defined as a locust situation, or the threat of one, beyond the capacity of the Unit to deal with unaided. This should be a declaration by the Minister of Agriculture and Natural Resources on the advice of the head of PPD. This declaration should empower the head of PPD tc second PPD regional staff and resources, especially vehicles, to the Unit for the duration of the emergency. It should also release resources, especially money, to permit supporting action by the Regional Entomologist and his remaining staff should that be necessary.

It would be necessary at the same time to examine through the Steering Committee, the provision of assistance by donors. This would be essentially for replacement of pesticide, vehicles and other commodities because of the delay between the request and its being fulfilled. It is emphasized that the aim of the Core Project is for Sudan to be able both to detect upsurges, and to combat upsurges in the country or initial invasions without additional support. A continuing plague would, of course, require replacement of resources.

6.3 Technical Sustainability of the Locust Unit

If a plague continues there will be a temptation to divert the major part of PPD's resources to locust control. That would be a mistake. As recent experience in North Africa has shown effective locust control is not just a matter of men, aircraft and pesticide. Moreover, when the plague finally ends, unless the original unit still exists, locust survey will once again fail to be carried out and the next upsurge will once again find Sudan unprepared. A large unit cannot be justified during a recession and would in practice never be maintained. A small unit can be adequately employed on desert locust survey, minor recession control, survey and control of other locusts, on training and on development work such as equipment evaluation and field testing of pesticides. Because of the difficulty of giving such a unit priority in resources during a recession, some limited donor support, especially with vehicles and technical assistance, should be envisaged on a long term basis.

7.0 Regional and International Aspects

These have been dealt with inter alia under other headings. Sudan has tacit obligations to control desert locusts within its borders as an essential part of plague containment and plague prevention on a regional level. Conversely, Sudan depends on others as well as on its own efforts for protection from the desert locust. Sudan has more defined international obligations through DLIS (Desert Locust Information System) at FAO, to carry out surveys and to transmit the findings to Rome.

Sudan's formal regional obligations are confined to its membership of DLCOEA. The charter of DLCOEA defines that organizations obligations as being to assist members to combat desert locust outbreaks beyond their own resources. DLCOEA has clearly been unable to perform that task fully during the recent upsurge. It has been FAO's declared policy to strengthen the national locust units in individual countries. The merits of a regional, compared with a national, approach are a matter of debate. But in practice an assessment of the service of the relevant regional organization, where one exists, and is able to provide, cannot be avoided.

8.0 Locusts Other than Desert Locust

8.1 Migratory Locust

This is currently a minor problem, and as has been pointed out, the population dynamics of the pest means that regional responsibilities are not as imperative as for desert locust. A threat of invasion from the west might arise but probably not without a year or more's warning. If a major invasion did occur it would pose virtually the same problems as an invasion of desert locusts. Swarm and band behavior might differ in ways which could influence control tactics - swarms might fly lower, and bands march more slowly and be less visible from the air; dosage rates for effective control might differ also. But there is no way of studying these problems in advance.

Migratory locusts persistently infest certain habitats in Sudan, of which the most important is irrigated sugar cane. These should be inspected regularly by officers of the locust unit. It is difficult to define the infestation level which would justify control. Locusts tend to get 'tied up' in dense

habitats such as cane, so inhibiting gregarious behavior until relatively high insect densities occur. This can lead to the sudden formation of unexpectedly large swarms. So control is probably justified before swarm formation has taken place. Sugar cane is an extremely difficult vegetation from the spraying standpoint; it is virtually impossible to get the spray to penetrate. The best chance of control would be likely to occur in the early morning and late afternoon when both nymphs and adults would be near the top of the vegetation. Once the wind rises the locusts would be likely to descend and not climb up again until the calm of late afternoon. Flight is most likely then. Since sedimenting droplets are necessary for control in still air a coarse Micronair blade setting would seem best when ULV methods are used, unless the insects are flying.

Cane is a valuable crop and defoliation by locusts will certainly decrease yield. The grower might reasonably be expected to bear at least some of the cost of control.

8.2 Tree Locust

Tree locust is a purely local problem with no international ramifications. What little is known about the insect is enough to form the basis for effective control. It is most gregarious at the adult stage. Swarms move little. It would be sensible to assign the responsibility for control to a locust unit. One would expect local people through the Regional Entomologist and his staff, to report the presence of swarms.

Control should not be difficult but a certain amount of development work might be needed to discover the best technique. Ground control of roosting swarms in the hours after dawn might well prove feasible.

9.0 Grasshoppers

A number of species go to form the grasshopper complex in Sudan. Aiolopus simulatrix and Oedaleus senegalensis are the two most important. Neither has been studied in the same detail as either desert or migratory locust, although both are known to migrate. Basic research would be justified only if it were possible to tackle grasshopper by overall population reduction. That depends fundamentally on the area which would need to be treated to eliminate at least three quarters of the total population. Since grasshoppers

gregarize only feebly that area is unlikely to decrease much with an increase in numbers. Almost certainly the area would be so great that the cost of control would be prohibitive, as well as being a possible environmental risk. General population reduction has been tacitly rejected in Sudan. That should be accepted unless contemplated research indicates otherwise.

The alternative is control only in infested crops. In that area fundamental research on biology, behavior and migration becomes something of a luxury. There are more immediate problems. Indeed until some basic questions are answered it would be difficult even to justify large scale donor support for control. Research to determine threshold levels for grasshopper control are part of the project and will provide needed answers for control operations.

9.1 Existence of Crop Loss

The first question is whether or not grasshopper cause a significant loss in yield in the particular infested field. This itself is no easy question to answer since loss will be a function of the crop, its stage of development and the stage of development of the grasshopper population, as well as grasshopper numbers. The next question is whether eliminating the grasshoppers will produce an increase in yield. In particular does reinfestation occur. If a treated and untreated field contain similar infestations a week or so later, whether through local movement or invasions from a distance, the benefit of spraying is likely to be small. This may be particularly important at the sprouting stage since then a light infestation can kill many crops, through the insects nipping the growing point.

Assuming one discovers that control produces long lasting protection and a significant increase in yield, it then becomes important to develop appropriate control methods. The cost of these, set against the value of the crop saved, will allow threshold levels to be set. These may well be set lower than a simple cost/benefit ratio would suggest.

9.2 Basis of Control

If it is accepted that grasshopper control, if it is worthwhile, will be a crop protection activity, then aerial control will not be an appropriate method of treatment. Vehicle mounted sprayers would be likely

to cause unacceptable damage to the crop. Tractors and vehicles on which to mount sprayers, would be difficult to provide. Control methods must be such as can be carried out by the farmer or by PPD staff on foot.

9.2.1 Baiting

This requires the spreading of pesticide in granular form mixed with a bait such as groundnut husks. Preliminary work has shown that this technique can be almost completely ineffective if the pest prefers the alternative source of food provided by the crop. The method requires the transport of very large quantities of material since in the region of 100kg/ha needs to be applied. Propoxur and bendiocarb have replaced HCH but application rates in terms of active ingredient for effective control, and the situation in which the technique will work, have yet to be determined.

9.2.2 Dusting

The same pesticides are likely to be used for dusting as for baiting. This is probably a more reliable method than baiting but again application rates for permitted pesticides are not known. The usual method is by shaking a sack. The "puffer duster" is a simple way of achieving more effective, more controlled and safer application.

9.2.3 Emulsifiable Concentrates

Nearly all portable machines such as knapsack sprayers were designed to apply E.C. materials diluted with water. The trials of pesticides for grasshopper control conducted outside Sudan already mentioned, have concentrated on ULV formulations but application rates expressed as g ai/ha might not be very different from E.C. This, however, needs to be confirmed by field trials.

9.2.4 ULV Formulations

ULV application presents problems. There is only one suitable hand sprayer namely the Microulva (there are Microulva copies but to them the same restrictions apply). The drawback of this machine is the supply of torch batteries which are the power source; it is difficult to prevent them being stolen. There have been somewhat unsatisfactory attempts to produce a hand cranked spinning disc device. Nevertheless ULV application should be investigated since application rates expressed as g ai/ha may prove to be significantly less than with E.C. application. If that is so one must then balance the lower cost of ULV application against its greater sophistication. Microulvas have, however, been used with success by peasant farmers growing cotton in other parts of Africa.

9.3 Organization of Control

The organization of grasshopper control, assuming that a system of crop protection proves feasible, presents fundamental problems of long standing. One might merely provide the farmers with advice leaving it to him to procure the necessary pesticide and equipment, and to carry out control. This is clearly not practicable with most farmers in Sudan.

One can provide the pesticide or the equipment or both either free or at a nominal cost, and leave it to the farmer to carry out control. This however, requires a decision about which fields need treatment. That should not be left to the farmer to decide. If it is, either everyone will want materials or no-one,or the keen farmer will want to be supplied but not the less active ones. The level of infestation will not be the basis for control.

Supply to the farmer requires a system of threshold criteria estimation by PPD staff. Baiting and dusting are methods which the farmer can use with little training and with only the simplest of equipment. Knapsack sprayers applying E.C. materials might be distributed on a village basis but this presents problems, not least of maintenance.

Both the decision to carry out control and the application itself might be carried out by PPD staff perhaps on a partial repayment basis. This might be in response only to a request by the farmer. Even this has its problems; the farmer and the PPD officer may not agree about whether or not control is needed. PPD must

be able to respond quickly to all requests if it and the system are to have either credibility or value. It is clear that grasshopper control is a proper regional responsibility of the Regional Entomologist and should not be organized like desert locust control.

9.4 Threshold Estimation

It is not sufficient to show that significant crop loss caused by certain levels of infestation can be prevented by control at reasonable cost. It is necessary to devise a simple system which PPD field staff can apply, to estimate when 'threshold levels' have been exceeded.

9.5 Countrywide Grasshopper Incidence

If resources for grasshopper control are to be distributed to regions where the infestations are heaviest, there must be a system of sampling and reporting. This might, in the long run, provide a basis for estimating risk either later in the season or even in the season ahead. A thorough system allowing the production of density maps such as has been developed for range grasshoppers in Canada, is much beyond the resources of PPD. Regular sampling by PPD staff using transect counts at the same selected sites at regular intervals, might be sufficient. In the order of 50 sample sites visited at bi-monthly intervals during the season in each region subject to grasshopper infestations might be sufficient. These counts,and observations on crop growth and rainfall, would be transmitted to Khartoum by radio, and it would be the task of the Information Officer of the Locust and Grasshopper Section to plot, evaluate and store these.

10.0 Biological Control of Locusts and Grasshoppers

The possibility of biological control of locusts and grasshoppers was envisaged over a century ago. According to Greathead (unpublished report), the introduction and successful establishment of the Indian mynah (Acridotheres tristis) in Mauritius in 1792 to control the red locust (Nomadacris septemfasciata) was one of the earliest recorded biological introductions against any pest. Pathogenic organisms were known as

biological control agents since 1890's but most attention has been directed to parasitoids and predators.

There are three basic approaches to biological control:-

a). Importation of exotic biocontrol agents such as parasitoids, predators and pathogens from other continents
b). Enhancement of indigenous natural enemies
c). Periodic release of propagated natural enemies.

10.1 Insect Natural Enemies

10.1.1 Major Parasitoids and Predators

A comprehensive review of insect enemies of Acridoidea was prepared by Greathead. Many of the important African locusts and grasshoppers species were studied.

Egg predators of the desert locust were reported to cause considerable mortality. For instance Stomorhina lunata (Calliphoridae) was found to cause up to 90% mortality and Systoechus Spp. (Bombyliidae) up to 20% mortality to egg fields of gregarious populations in Eastern Africa. In Saudi Arabia, Trox procerus) (Trogidae) was observed to cause up to 75% mortality; and larvae of Mylabris Spp. was also found to inflict considerable damage on eggs of the desert locust and other species during outbreaks.

Mortality rates among solitary populations are much lower and are mainly caused by the egg parasitoids, Scelio Spp. (Scelionidae). Post-embryonic stages of the desert locust are parasitized by nemestrinids and sachrophogids; and locusts and grasshoppers in the northern temperate climates are also found to be extensively parasitized by Acridomyia Spp. (Muscidae).

The main predators of locusts and grasshoppers are birds, reptiles, jackals and other insectivorous vertebrates.

10.1.2 Introduction of Insect Natural Enemies of Locusts and Grasshoppers

Table 2 shows a record of biological control introductions of insect natural enemies of locusts and grasshoppers. Two of the introduced species were able

to establish themselves in the new habitat, and of these two only the natural enemy of the rice grasshopper (Oxya chinensis) was believed to be successful.

10.1.3 Conclusion

Migratory species of locusts are unsuitable targets for classical biological control introductions; and natural enemies effective against solitary populations are of little value against gregarious populations. In theory it is possible to establish natural enemies in well defined outbreak centers so as to achieve long-term suppression, but in effect this is less likely because most of the promising agents are probably already present and do not seem to have detrimental effect on locust populations.

Inundative control is not feasible at present because large numbers of biocontrol agents have to be reared on locust and the number required are too large to be realistically produced.

Insect natural enemies may prove to be effective against mobile grasshopper populations and they may cause heavy mortality on natural populations of locusts, but there is no evidence that they prevent outbreaks, although they may help to terminate them.

10.2 Pathogenic Biocontrol Agents

Many of the pathogens known to infect locusts already occur in outbreak areas and efforts are made to identify virulent strains and introduce exotic species or strains from other areas. However introductions may be less successful because of the ecological limitations on the spread of exotic species. Therefore augmentative use of the virulent indigent pathogens may be the best option. To satisfy this requirement there is need for identifying suitable pathogenic organisms from amongst the known viruses, fungi, nematodes and protozoa.

10.3 Constraints on use of Pathogens

According to Greathead (unpublished report) there are four constraints on any pathogen for locust control:-

a. It must have acceptable host specificity and be safe to non-target species including man.
b. It must be suitable for simple and cheap large-scale production at either high or low technology levels.
c. It has to be tolerant to the adverse tropical climatic conditions of high UV-radiation and low relative humidity.
d. It must cause acceptably rapid kill of a large proportion of the population.

These constraints rule out viruses, nematodes and protozoa as likely candidates. For instance the entomopox virus, recently found in locusts, does not have proven host specificity, has not been proven safe to non-target species, is expensive to produce and difficult to protect against UV radiation.

As for the protozoan, the most widely known species is Nosema locustae which is specific and safe but very expensive to produce and very costly to apply in the field in order to obtain reasonable kill. Nosema was field tested in Cape Verde and in Mauritania and the results obtained indicate low levels of infection, not exceeding 26% at 28 days post application. The only African species naturally infected by Nosema is the Senegalese grasshopper. Some other species of grasshopper and locusts were found to be infected under laboratory conditions only.

So far there have been no experiments or demonstrations to support the conclusion that Nosema locustae can be used effectively to control African locusts and grasshoppers. Thus there is need for further tests to generate data on control of locusts and grasshoppers by this protozoan before a final conclusion is reached.

Nematodes (Steineznema and Heterorhabditis) are expensive and difficult to produce and have an absolute requirement for free water to infect.

Although all three groups of biocontrol agents have good potential for pest control in certain situations, yet certain basic problems have to be solved first before they can be utilized.

10.4 Potentially Useful Pathogens

10.4.1 Bacteria

Bacteria are the most widely used pathogens for pest control with Bacillus thuringiensis being the most commonly applied. B. thuringiensis is known to be specific, safe, cheap to produce and highly effective. However, so far no strain toxic to Orthoptera has been discovered and therefore extensive investigations are

12/x

needed to find out more about virulent strains. But even if a toxic strain is discovered there will still be the need for proper formulation in order to overcome the high sensitivity of this bacterium to UV radiation which is usually very intensive in the locust outbreak areas.

10.4.2 Fungi

Greathead compiled a selective list of fungal pathogens of Orthoptera found in many parts of the world. It appears from his list that there is a wide range of pathogenic fungi already known, and a lot probably still remains to be discovered.

Although little attention was paid to these organisms during the past two decades, yet recently greater interest has been shown for taxonomic and basic laboratory studies of some species such as Metarhizium Anisopliae and Entomophaga grylii complex. The main reason for the recent revival of interest in fungal pathogens is the realization that it is not necessary for infection to occur under exceptionally wet climatic conditions. Infection from an applied fungal innoculum can occur independent of humidity but high humidity is required for spore formation so that the disease may spread within the treated population of locust and grasshoppers. Future control strategy should therefore aim at the maximization of the kill from the initial application which may be repeated in the same way as in the case of chemical pesticides.

Hence success of potentent pathogenic fungi depends largely on proper formulation and application technology. The target species must be infected immediately after application of fungal inoculum and before it is inactivated by the unfavorable climatic conditions.

So far little attention has been given to oil-based formulations of pathogens although they appear to have a great potential. Unlike water-based formulations, they are less bulky and therefore handy for transport and application in remote areas by ulv methods. Oil-based formulations are also claimed to enhance infectivity because oils spread readily over the insect body surface and penetrate easily through the lipophilic insect cuticle.

Fungi used in this way are essentially direct alternatives to pesticides. Fungi are unlikely to be an attractive alternative unless pesticides used in locust and grasshopper control adversely affect the environment - which should not be the case.

10.4.3 Conclusion

Biological control which utilizes natural enemies such as predators, parasitoids and pathogens to suppress pest populations to levels below the economic threshold levels, remains the most effective force regulating insect numbers in the environment. The technological advances and the historical success of biological control provide a basis for a biological control alternative in AID locust and grasshopper control programs in Africa.

However, at present there is no successful biological control program for locusts and grasshoppers, and the prospects for development of such a program cannot be expected in the short or medium terms. Hence field tests with promising natural enemies such as Nosema on different species of grasshopper and locusts may be encouraged, and research on cost effective formulations and application methods must be supported.

Survey of natural enemies (predators, parasitoids and pathogens) in outbreak areas and other habitats infested by grasshoppers and locusts should be facilitated. Efforts to develop cheap mass-rearing techniques for promising natural enemies and suitable formulations and application methods should receive high priority in the medium and long term programs.

Such development work requires specialized knowledge and substantial resources, and it is not envisaged in the Locust and Grasshopper Control Project.

11.0 Cultural Control Practices

Planting of short-season crop varieties or early seeding may help avoid late-season grasshopper infestations, because the crop would be mature and more tolerant. On the other hand, late sowing may sometimes save the seedlings from the early attack by grasshoppers because they will be attracted to alternative host plants. However, planting dates are usually inflexible because of the erratic rainfall, hence this method is impractical in many parts of Africa and the Middle East.

Proper conservation of land, whereby good plant cover is maintained, may decrease suitable grasshopper and locust oviposition sites which is usually associated with poor plant canopy. This requires good management of rangeland to avoid over-grazing and prevent frequent bush fires. At present these measures

are difficult to implement but extensive and aggressive extension programs may help overcome this problem.

Ploughing to expose eggpods to unfavorable climatic conditions may also help decrease the incidence of grasshopper infestations.

12.0 Host Plant Resistance

Certain crop plants are less attractive to grasshoppers and locusts than others. Therefore through careful selection and propagation reasonably tolerant crop varieties may be developed. Non-preferred crop varieties planted in rainfed arid environment may escape early season grasshopper attack because the pests will infest surrounding vegetation which provides an alternative food source. But hungry swarms of desert locusts will attack any crop variety and so will grasshoppers late in the season when the vegetation surrounding the fields dries up.

Traditional sorghum varieties usually contain varying amounts of cyanide and phenolic acids which are released when leaves are bitten; they also contain leaf wax components. All these together constitute the antifeedant defense mechanism for the sorghum plant.

13.0 Antifeedants

Certain natural plant substances are known to protect crops from locust and grasshopper attack when extracts of these substances are applied to plant foliage. One of these is Azadirachtin which is found in seeds and other parts of the 'neem' plant, Azadirachta indica. The 'neem' tree is very widely grown in villages and towns in Africa and Asia and is not attacked by certain insects including grasshoppers and locusts. Extracts of this plant are known as antifeedant for the variegated grasshopper and the African Migratory Locust. In India a water spray solution of 0.1% neem kernel extract and a 1% mixture of ground neem seeds and dry soil when applied as dust were both found to protect crops against desert locust attack.

In Togo it was found that crushed neem seeds suspended in water at 10:1 repelled grasshoppers when applied to crops every 3 weeks or every 4-5 days when infestation was heavy. Crude preparations of neem extract made by farmers were found to have significant antifeedant effect against the grasshopper Kraussaria angulifera in West Africa.

These antifeedants usually give good results when there is an alternative food source and when applied more frequently. However frequency of applications has to be economically justified.

Neem and other antifeedants may have adverse environmental effects and therefore they should be carefully studied before extensive use is recommended.

The potential advantages of Azadirachtin and other similar natural antifeedants when compared to broad-spectrum synthetic pesticides include greater specificity, relative safety, low cost and provision of work for villagers.

14.0 Growth Regulators

Growth regulators are substances which interfere with the normal metabolic and development activities thus causing the death of affected individuals. DIMILIN is one of these compounds which is now recommended for use against a number of crop pests. It is claimed to be specifically more effective against species belonging to the Lepidoptera, Coleoptera and Diptera; fewer species in other orders are also known to be susceptible.

DIMILIN interferes with the deposition of chitin, one of the main components of the insect cuticle. After treatment with this compound, larvae have difficulty with molting and as a result they collapse and die. It is claimed that DIMILIN has an ovicidal effect, but it has no effect on adults. It is mainly a stomach poison with some contact action, but has no plant systemic action; consequently sucking insects are not affected. This compound may prove to be useful against chewing insects such as locusts and grasshoppers. Its action may be enhanced if applied in a mixture containing an appropriate insecticide. DIMILIN has to be tested against locusts and grasshoppers and its environmental impact be assessed before recommended for use against grasshoppers and locusts. It is however believed to be highly persistent.

Essentially growth regulators are 'pesticides' with a different mode of action. They pose the same application problems and pose similar potential risks.

15.0 Conclusions

Although the task of organizing and conducting an effective locust control operation seems almost

impossible, it can be accomplished. There are, however, several requirements for this to occur, other than those technical aspects outlined and recommended in this paper. Even if all the guidelines and technical plans are followed, an operation of this magnitude cannot be successful without the concentrated effort of those parties involved, ranging from the PPD, MOANR to FAO to donor organizations. There must be strong lines of frank communication between these bodies, thus allowing for immediate action to be taken when a situation arises. A locust outbreak will not wait for a committee to debate and make a decision, therefore time and expediency are of vital importance. Even the best laid technical plan has failed due to bureaucratic delays. The Locust Control Steering Committee has in the past been the body which overcame this problem. It is a functional and effective group, with the ability to facilitate solutions, quickly and accurately. It's maintenance is vital to the success of the project.

ANNEX F

SOCIAL SOUNDNESS ANALYSIS

CONTENTS

SOCIAL SOUNDNESS ANALYSIS

1.0 Project Beneficiaries

The main beneficiary of the Medium-Term Desert Locust Control Project is the Plant Protection Department, with the primary beneficiary being the extant Locust/Grasshopper Section, and the recently created Locust Control Unit. Benefits that will accrue to the institution and its personnel include improved institutional capacity for locust control, increased skill levels, increased safety levels through improved pesticide handling techniques and reduced costs for overall locust control.

Secondary beneficiaries will be those in the rural sector whose crops are at risk during locust infestation, as well as pastoralists who will benefit through continued access to forage that would be destroyed by locust attacks. Effective locust and grasshopper control will reduce the potential for widespread crop losses, which is a threat to rural communities.

Tertiary beneficiaries are regional and international: a locust infestation has the potential to infest and cause substantial crop damage over a large area in Africa north of the equator and southwest Asia as far east as India. The project will assist in containing locust infestation and reducing the possibility of the development of plagues (See Fig. 1).

2.0 Project Participants

The primary project participant will be the Plant Protection Department. Not only will the Locust/Grasshopper Section participate, but the mechanical, procurement, pesticide analysis, and transportation sections will be involved to some extent as well.

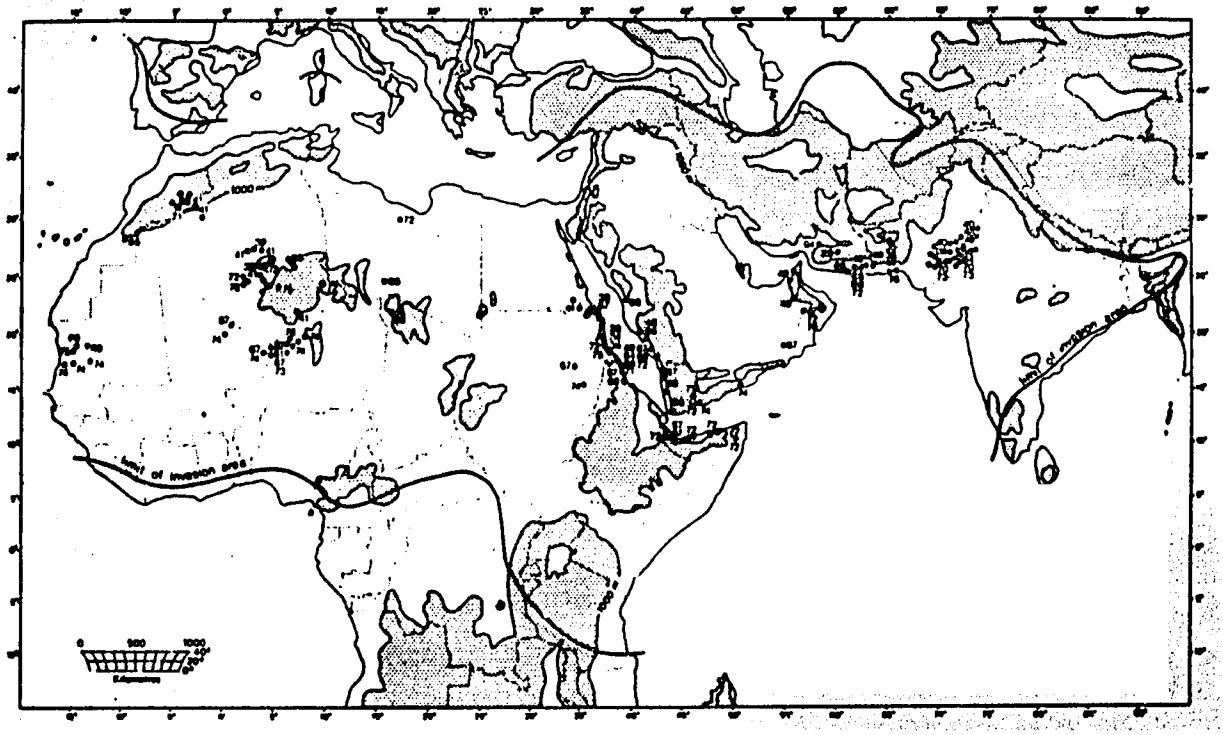
There are also a large number of donors and potential donors. FAO is the implementing agency. USAID, the DGIS (Directorate Generale voor Internationale Samenwerking) of the Dutch Ministry of Foreign Affairs, (working through the Dutch Embassy, Khartoum) and the EEC have agreed to commit funds to the project.

Other donors have expressed, through the Locust Steering Committee, a willingness to contribute funds to any emergency control effort.

To date, donor efforts have been coordinated

Fig. 1 Area of Actual Gregarization of Locust

Source : Locust Handbook, ODA, 1988, p.63.



through the Locust Steering Committee, which is to be lauded for its efforts, and for recognizing the necessity of creating an institutional structure under this medium-term project for desert locust control.

At a tertiary level, "local" populations will be involved. Indeed, they already are; serving as scouts for the locust survey efforts, and occasionally assisting in minor control efforts.

For the grasshopper portion of this project, which is a research and crop protection activity, local participation is essential.

3.0 Accrual of Project Benefits

From a behavioral standpoint, project participation is elicited through the perceived accrual of benefits, or a perceived reduction of social costs. Individuals react according to benefits they see accruing to themselves, which can be either material or social in nature. Doing a "good job" (or a good deed) can be as important to some people as receiving extra monetary compensation. The same holds true for "social approval".

The Medium Term Locust Control Project is essentially an institution-building project, and a great deal of the impetus for the project has come from within PPD itself, and from the donors involved. It is expected that there will be very little resistance to institutional strengthening from within the PPD.

Any resistance to proposed changes is most likely to come from the Regional PPD Units, where the Regional Entomologists currently hold centralized power.

The sudden separation of resources that have formerly been jointly shared may lead to some internal problems in the Regional offices. It should be noted however, that this will most likely be mitigated by the short term availability of additional resources for other plant protection activities.

It is a truism, however, that control of resources means control of power. There are innumerable examples of resources being directed to specific activities or sections within a project to the exclusion of "parent organization" activities.

In the case of the PPD, however, this should be mitigated by the fact that locust control activities have traditionally absorbed about 70% of the total PPD operating budget in any event. This project will make available increased resources for other crop protection activities in the regions. This is achieved at no extra cost, as the personnel budget will continue to be paid out of general PPD funds. This, combined with a

training program designed to convey the relatively different LCU mission of the LCU should mitigate against problems within the regions.

A crucial part of the project is the strengthening of HQ activities, including, most importantly, the information collection and dissemination function. It is expected that these activities will be substantially and positively affected by the proposed project. Ties to FAO/Rome's Desert Locust Information Service (DLIS) should be strengthened, and ties in the reverse, to the field as well, since the LCU will have its own direct communications with field survey units, rather than having communications routed through the Regional Entomologists. Fig. 2 details the routing of information from the field to FAO.

4.0 Project Impact

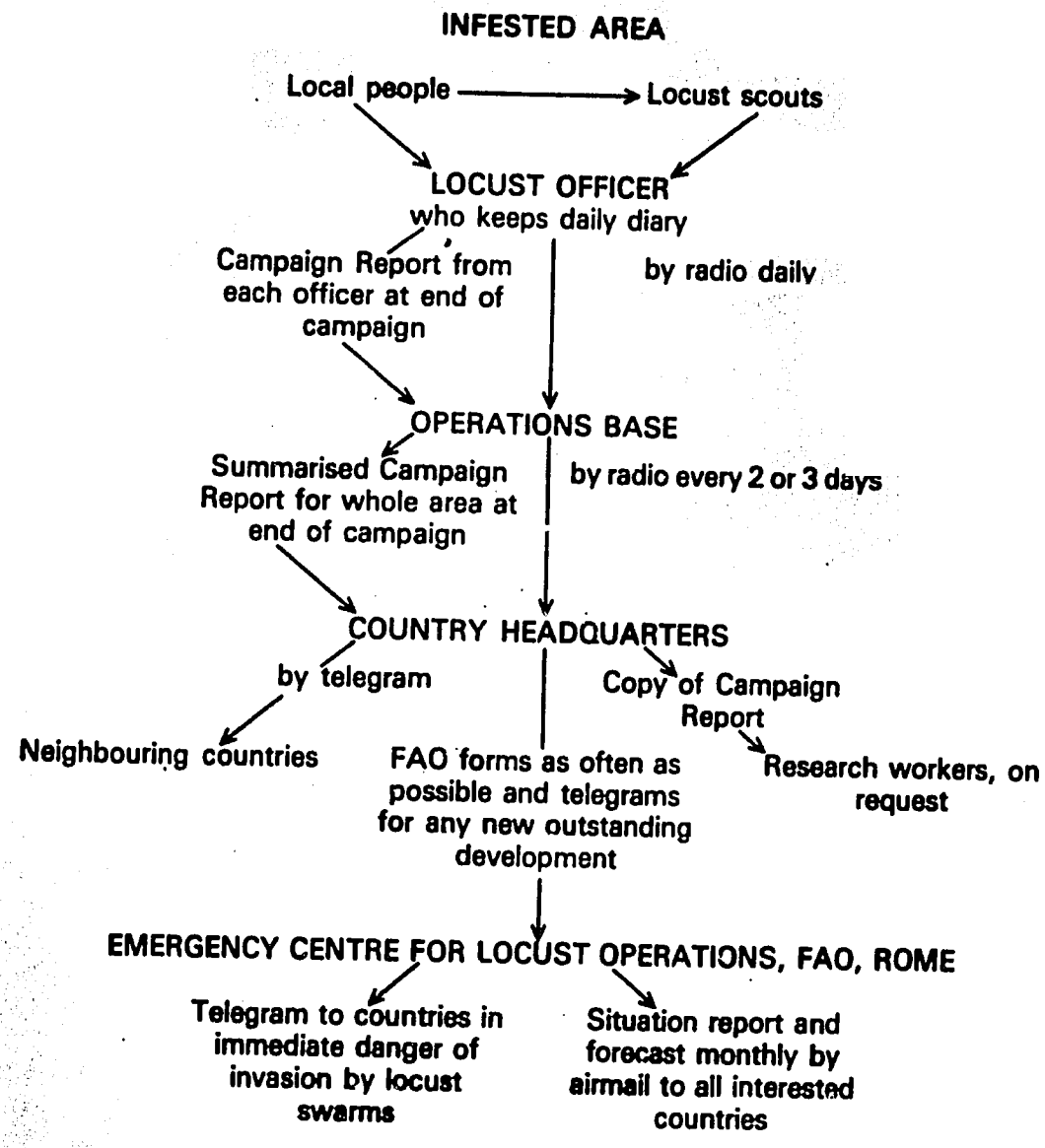
4.1 Donor Impact

An issue rarely addressed is the role of the technical assistance team. TA teams tend to be ad hoc adjuncts to long-standing institutional structures, and while there are good and bad points to this, the simple fact is that TA is not a sustainable activity and power should not be concentrated in the TA team's hands to any degree. Their function should be guidance and training, where appropriate. Since LCU is a new creation, there are both advantages and dangers to any TA structure that may be created.

The structure of the TA/LCU interface are largely a result of the interpersonal relationships that develop. An important part of the TA role is project compliance with donor procedures, something that host country counterparts may be unfamiliar with. In such a project as this, it is crucial that this training role be fulfilled to the utmost, as it offers a good opportunity for GOS personnel to deal with a variety of donors and donor procedures. At the same time, the TA team must be sensitive to GOS procedures. They are by and large "set in stone", and there are many examples of projects failing to take host country procedures into account, thereby lengthening the implementation procedure.

The Locust Steering Committee has had a positive impact in the past few years on desert locust control efforts. This multi-component body has indeed provided the main impetus for the medium-term project, and will continue to be involved at the policy level. This is a decided advantage, as well as a rare occurrence in the Sudanese context. It is more normal for a project to be

Fig. 2.


INFESTED AREA
Local people
Locust scouts
LOCUST OFFICER
who keeps daily diary
Campaign Report from each officer at end of campaign
by radio daily
OPERATIONS BASE
Summarised Campaign Report for whole area at end of campaign
by radio every 2 or 3 days
COUNTRY HEADQUARTERS
by telegram
Copy of Campaign Report
Neighbouring countries
FAO forms as often as possible and telegrams for any new outstanding development
Research workers, on request
EMERGENCY CENTRE FOR LOCUST OPERATIONS, FAO, ROME
Telegram to countries in immediate danger of invasion by locust swarms
Situation report and forecast monthly by airmail to all interested countries

designed and a Steering Committee (under whatever nomenclature) formed, which then meets formally only rarely. GOS and the donors have worked closely together on project development, to date, which has gone a long way towards assuring project acceptability to PPD.

4.2 Impact on the Agricultural Sector

4.2.1 Locust Control

As can be ascertained from Fig. 1, the agricultural sector has a very small participatory role in LCU control activities, and are involved mostly in survey work, as scouts. Breeding grounds and control areas tend to be far from farming communities, though they may affect pastoral grazing areas.

In any event, most rural people have little knowledge of PPD activities. Coughenour and Nazhat (1987), in their survey of Northern Kordofan, have shown that rural people have had little contact with the agricultural services departments and that those contacts, when they have occurred, have been limited to one-time activities or campaigns such as seed dressing or sporadic pest control. Indeed, our own experience indicates that most people have never seen an extension agent. The common excuse given for this is lack of resources, which is not entirely untrue (but is a poor excuse). Current research clearly indicates that state policies are directed to servicing the irrigated and mechanized rainfed schemes that are (incorrectly) viewed as being the primary foreign exchange earners for Sudan. This project's economic analysis shows that about 90% of total agricultural product is generated out of so-called "traditional crops". At the same time, Shaheddin (1986) has shown that the net coefficient of foreign exchange dependency (CFED) is highest for the irrigated sector, largely as a result of imported inputs and technologically depended agronomic practices.

The distribution of regional PPD offices and extension clearly shows that state policies are to serve the schemes and merchant farmers who share the world view of the state bureaucracy, since they tend to surround the state and are able to use it as an extractive mechanism. Thus, the claim of the various agricultural services departments that they are resource scarce in the regions is partially true; however current levels of inactivity are scarcely excusable.

Agricultural education at all levels is clearly mandated to the Extension Service. This was plainly stated by senior PPD management, and agreed to in our

interviews with extension personnel in Khartoum. However, the extension service is plainly reliant on information transfer from PPD to extend information, and their levels of activity tend to mitigate against any knowledge to farmers. As Coughenour and Nazhat have shown, this is largely accomplished through farmers' own personal contacts with friends, family and in the souk.

A suggestion continually made is that use should be made of the radio, as most regional centers have radio stations. This is good thinking, but bad research (indicating the generally on-the-road, urban, dry-season bias of planners), since in both El Obeid and Nyala, for example, the local radio stations are scarcely audible more than 15km away from town. Radio Omdurman is unreliable as well, as reception is highly dependent on weather conditions.

We strongly recommend that the project make certain that scouts, who are the front line of contact with the PPD, are given training in the structure and functions of control activities, so that this information can be disseminated in their villages. This would likely be necessary only in the event of a severe infestation and large control campaign. While Fenitrothion is not hazardous to humans in the dosages in which it is sprayed for locust control, people may not know this, may not care, etc. It is crucial to note, for example, that people in Chad and Darfur eat jarat (locusts) and may perceive large masses of dead locusts as a windfall. This is compounded by the long period since the last serious infestation. Inasmuch as knowledge may be lacking in PPD about campaign matters, it is certainly lacking in the villages as well.

An option that should also be examined, perhaps in conjunction with the extension departments, is area or village council training programs. There may be an influx of donor funding into Extension that could be tapped to run some one-day seminars to explain PPD procedures to the local populations.

Transhumance is a major production strategy in the traditional sector. IN deed, pastoralists are those most likely to be affected by control activities, as they range far north of the limits of settled agriculture, into the desert locust breeding grounds.

This sector is largely neglected by the extension services, and services offered have largely to do with animal health. It is doubtful that actual livestock routes have been studied to the degree of completeness needed to identify populations likely to be affected by control measures. While this information may exist in various places, it needs to be assembled, coordinated, etc. It is recommended that this be done as part of the monitoring effort, perhaps by someone at the Geography Department, University of Khartoum.

4.2.2 Grasshopper Control

This is largely a research component under this project. Grasshopper control is to be a "real" crop protection activity, as they infest areas and do not swarm. The object of the grasshopper control portion is to establish threshold levels and to determine when control is economically justified.

It is envisaged that when an actual need for protection activities arises that farmers will be expected to pay for inputs. While this is a laudable approach, one must be careful. There is often the perception among rural villagers that the state should provide inputs, otherwise, what are they there for? The fungibility (diversionability) of inputs should not be underestimated either. There has been a tendency for inputs to be directed towards the merchant farmers and away from the "small farmer" who, in any event, is highly dependent on capital obtained from rural financial markets for his operation, and is often in debt. This is a wider policy issue that cannot be addressed under this project.

5.0 Health and Safety Issues

There is no actual information about risk perceptions among PPD personnel handling pesticides. There is much anecdotal information, and that will be relied on here. There is a lack of equipment for loading airplanes, which tends to lead to unsafe practices when handling pesticides, and frequent spills. While fenitrothion is safe in dilution, in full strength it can be dangerous. All indications are that personnel handling pesticides are reluctant to wear protective clothing, largely because of the heat. While understandable, it is also dangerous. Under the project, proper protective clothing (lightweight) will be provided, as well as the equipment necessary to handle pesticides properly. It should be noted that training is a necessary, and relatively inexpensive, adjunct to this material upgrading.

One cannot assume, however, that health care will be available to those handling pesticides at all times. Health care in Sudan is scanty to say the least, and is organized along the lines of the agricultural services departments: concentrated in the riverine areas, with a corresponding paucity of services outside the major regional centers.

It is likewise dependent on the "medical model", and is not directed towards preventative or primary health care. There are frequent shortages of medicine even in Khartoum. All of this points to the need for good training for those handling or utilizing pesticides.

6.0 Conclusions

With all these caveats being laid out, it is our conclusion that the project does meet social soundness criteria, and that it stands a good chance of success from this viewpoint. We stress again the importance of training. It is not necessarily training that will result in the loss of personnel, as is the case in many projects, but the sort that will lead to improved management practices and efficiency in pesticide usage and application.

Improved communications should lead to improved ability to mount effective and timely control measures. Desert Locust control is a national and international problem, and the medium-term project adequately addresses social issues in meeting it.

ANNEX G

INSTITUTIONAL ANALYSIS

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INSTITUTIONAL ANALYSIS

1.0 Organizational Macro/Environment

The Plant Protection Department of the Ministry of Agriculture and Natural Resources is one of the agricultural services departments within the Ministry. Like the other departments (Extension, Horticulture, Seed Propagation and Agricultural Engineering, it is both horizontally and vertically autonomous. For some years there has been a proposal to appoint an undersecretary for services, but the post remains unfilled. At the provincial level these departments were once organized as Agricultural Services, headed by one director under whom the other sub-departments were located.

After 1982 this arrangement was replaced by a system of coordination at the regional government level. The Regional Under-Secretary for Agriculture is responsible for all agricultural services units, which in the regions, such as Darfur, constitute the actual field departments of the Ministry of Agriculture. There is little interaction at present between these divisions, either at the national or regional levels. PPD regional entomologists report directly to Khartoum headquarters.

2.0 Micro-Environment

PPD's job is plant protection in the broadest sense of the word. In addition to the Locust / Grasshopper Section, with which we are concerned here, there are several other control tasks allotted to PPD at the national level:

1. Water Hyacinth - this is virtually the only task of the Weeds Control Division, and is funded by contributions from the Joint Nile Commission. PPD's inputs are largely in terms of staff salaries.

2. Plant Quarantine and Store Pests - this involves the supervision of the main ports. There is virtually no work on pests in stored grain in the rest of the country.

3. Vertebrate Pests - control of quelea on a regular basis, and of rats during times of heavy infestations.

4. Pesticides - The Pesticide Regulatory and Residue Analysis Section handles all pesticide concerns within PPD. The Section registers all pesticides and maintains three separate laboratories in Wad Medani: the Residue Lab, the Bio-Essay Lab (which is largely working with the schemes and quality control issues) and the Formulation Lab. The head of this section is located in Wad Medani. There are plans to set up a small laboratory at PPD HQ in Khartoum.

5. Vegetable and Fruit Insect Control Section - this is a small unit, mainly used for training PPD personnel in extension techniques.

Chapter II* budgets have traditionally gone to the Locust Unit to a large extent. In 1987, the LCU absorbed 70% of such funds. It is important to note that there is no budget for any particular section per se, but that funds come out of a common pool.

A ministerial order (unnumbered) of 30 June, 1988 created a Locust Control Unit within the Locust/Grasshopper Section with autonomy in respect to its budget, personnel, and equipment and supplies.

Figure 1 shows the present organizational set-up of PPD. With some 4,450 employees, PPD has a very high level of staffing. However, PPD is a highly qualified organization as well: there are 19 PhD holders, 61 employees with MSc's, 143 BSc holders and 472 technical officers, holding diplomas.

A number of these technical personnel are deployed in the field. Table 1 shows the regional breakdown of protection personnel in the field. This does not include administrative staff.

These figures indicate a disproportionate distribution of personnel in the Central/Khartoum provinces, and an apparent lack of attention to the traditional sector in the regions outside the Nile Valley.

* GOS nomenclature separates the budget into three distinct sections: (a) Chapter I is personnel costs, and consists only of salaries, allowances, etc.; (b) Chapter II is (literal translation from Arabic) "running services, i.e., other recurrent costs; and (c) Chapter III, which is the development budget. In reality, this is largely composed of construction.

TABLE 1 TOTAL PROTECTION STAFF BY REGION

Central Region	632	23.9%
Darfur	291	11%
Eastern Region	350	13%
Kht. HQ	327	12%
Khartoum Province	189	7%
Kordofan	356	13.5%
Northern	388	14.7%
Southern	103	3% (Malakal only
TOTAL	2636	100%

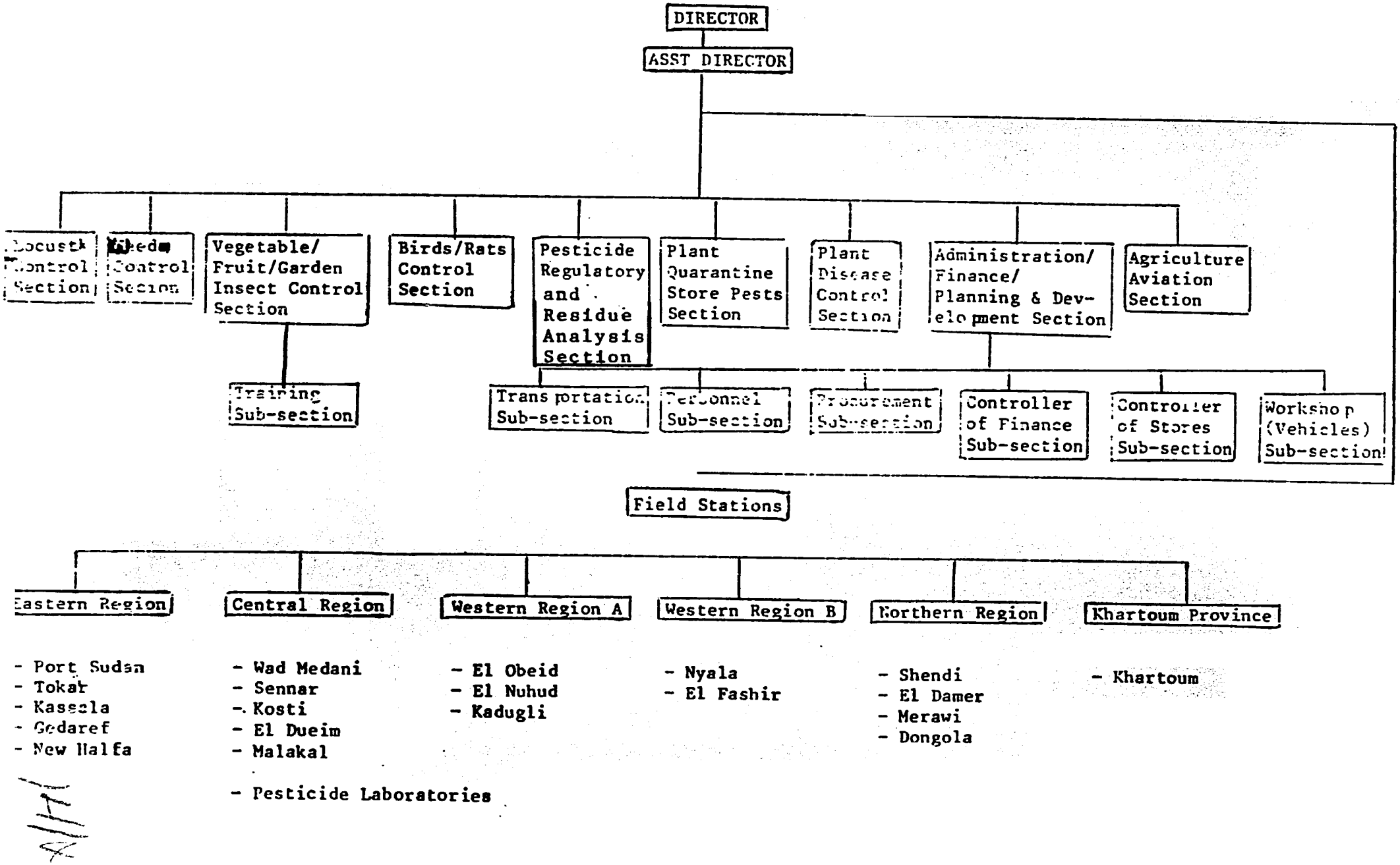
* Source - PPD Personnel Office

TABLE 2 NUMBER AND LOCATION OF SENIOR PPD TECHNICAL STAFF

	CONSULTANTS	INSPECTORS	TECHNICIANS
Central Region	17	70	135
Darfur	4	10	10
Eastern Region	3	27	35
Khartoum HQ	22	82	46
Khartoum Province	5	15	46
Kordofan	4	18	31
Northern	2	20	37
South	0	0	3

* SOURCE : PPD Personnel Office

Figure 1. PLANT PROTECTION DEPARTMENT ORGANIZATION CHART



All field officers are responsible to the Regional Entomologist, and can be assigned to tasks he deems necessary. The Regional Entomologists operate under the severe constraint of receiving PPD funds only on a monthly basis, which makes it quite difficult to plan activities.

3.0 Proposed Changes

Under the project it is proposed to establish five Locust Control bases and a HQ at Khartoum. The field bases will be at HQ, Kassala, Ed Damer, El Fasher and El Obeid.

The HQ staff at Khartoum will consist of a Head of Unit, an Information Officer, Administrative Officer, a Secretary and a Spray Equipment Engineer, who will also service machinery for grasshopper control.

Each of the field bases will have an officer in charge, two other technicians, and four drivers.

Each Unit will have one truck and three four-wheel drive pick-ups, plus radios. These commodities have been previously provided during emergency campaigns and constitute a GOS contribution to the project. Equipment and pesticide for the units will be assigned directly to them. During the summer campaign, the Units will normally survey on a regional basis, with the Red Sea winter survey being carried out by a team drawn from all the bases. Some officers from outside the Unit will also be seconded to the winter survey in order to give them much-needed field experience.

When needed either at periods of survey or during periods of major infestations where massive control operations are required, the LCU can deploy all its forces and temporarily draw staff from one region to another.

In the event that LCU officers are not required for locust duties, it is envisaged that he and his vehicle could be assigned to other PPD duties by the Head of the Locust and Grasshopper Section, after discussion with the head of the field Locust Unit.

The Grasshopper Section will consist of a Grasshopper Expert provided by FAO, a senior counterpart and support staff as needed. The goal of this section is primarily applied research, and they will work closely with the University of Khartoum. A separate sub-contract has been established for this, utilizing local currency.

Recognizing that grasshopper research is a plant protection activity, research will be conducted in one Region to establish threshold levels and assessment of grasshopper incidence and distribution. These threshold

levels will be used to justify control for various insect stages and stages of crop development for major food grains. Control methods suitable for use by farmers or unskilled laborers will be developed. Issues related to provision and use of control equipment and pesticides will be worked out during the research program. Care will be taken, however, to ensure that methods and material are appropriate to the traditional sector.

In the third year of the project, a system of control in one region will be established.

It is expected that some payment system by farmers will be devised. Farmers in the traditional sub-sector, however, tend to be cash-short, and rely heavily on the provision of informal rural credit (sheil) to meet their operating expenses. This expectation, therefore, will be carefully examined.

The organizational set-up does not require the seconding or employment of additional personnel by PPD, but does centralize resources, and their control, in order to be able to mount consistent locust control and survey activities. The purpose of this project is not to upgrade PPD as a whole, and the autonomy of the locust unit could become a sticky issue, by creating the possibility of some horizontal institutional jealousy, most particularly in the regions.

It is crucial that such potential jealousy be minimized and that cooperation be maintained with the Regional Entomologists, who at present supervise all PPD field activities. The Regional Entomologists' role as head of all actual crop protection activities should not be undermined and he should be kept informed as to the Locust Control Unit's activities and work plans.

This, however, should not allow him to intervene in day-to-day activities of the new Unit or give him power to divert LCD resources to other activities without approval from the head of the Locust/Grasshopper Section.

Fig. 2, below, shows the proposed organizational structure of the revamped Locust / Grasshopper Section and the Locust Control Unit.

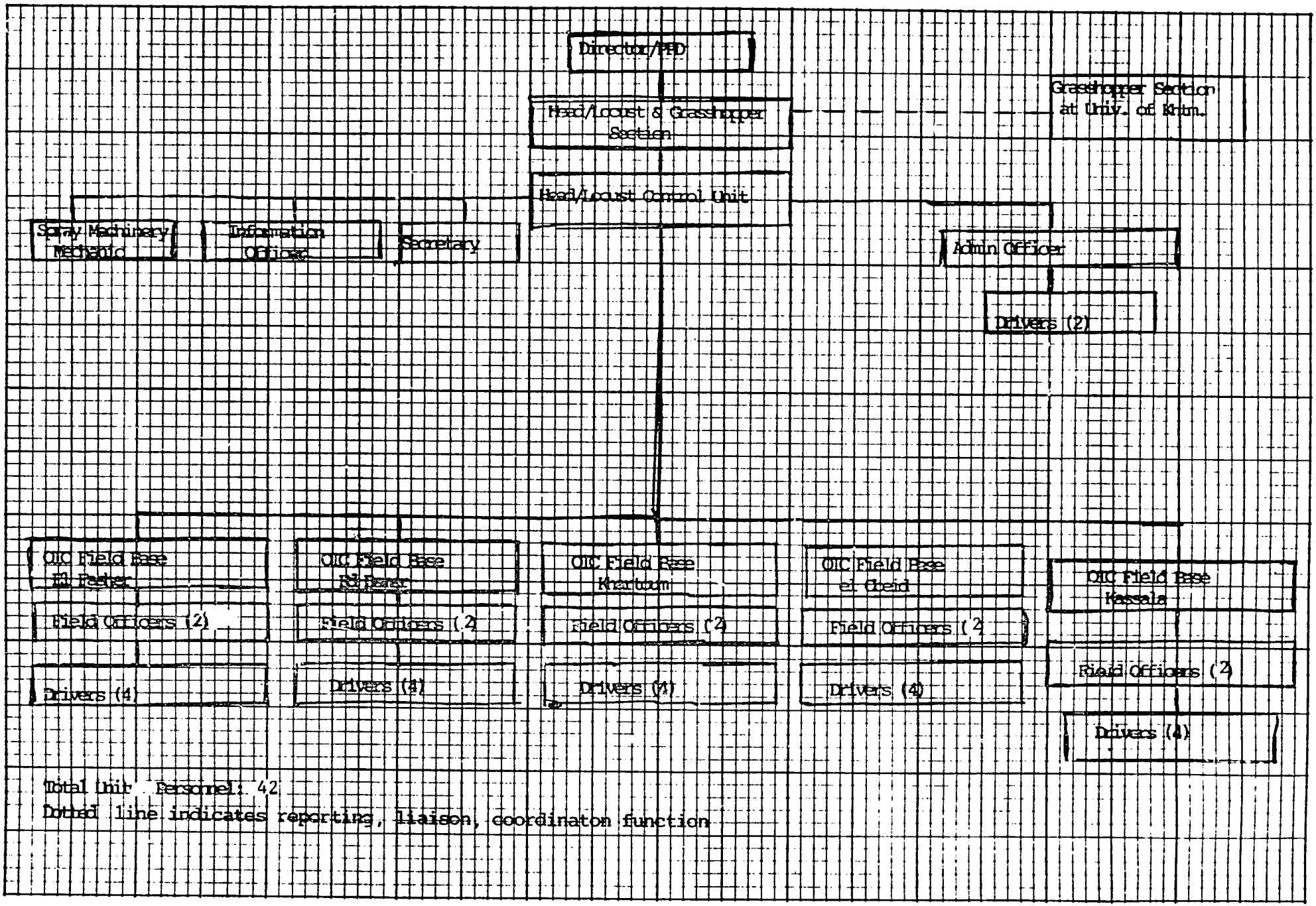
4.0 Operations and Management

4.1 Locust Survey.

The establishment of a regular system of ground survey in seasonally infested areas with additional survey in areas where breeding is suspected or which may have been subject to invasion. The areas for special survey will be indicated partly by aerial search for green areas and partly by improved analysis

FROM 10 x 10 TO 1 INCH
5TH LINE ACCENTED, 10TH HEAVY

Figure 2.



of the current situation and improved forecasts.

The methods of survey will concentrate on simple methods of population estimation, mainly foot transect counts, for non swarming populations, and reporting of sizes of gregarious infestations. Biological information will be restricted to stage of insect development and behavior. Information will be recorded on reporting forms in the field. An important source of information will be local people, especially pastoralists. The emphasis will be on the rapid transfer of accurate information by radio to the Information Officer in Khartoum. The date and location of sighting, and the route followed during survey are both essential. These tasks will be carried out primarily by officers assigned to the field bases.

4.2 Information Collation and Analysis

Locust information arriving at headquarters will be plotted each day and analyzed in relation to current weather. Weather information will be obtained by a daily visit to the forecasting office of the Meteorological Department at Khartoum airport.

Information for the situation outside Sudan will be derived mainly from FAO, either through the Monthly Bulletin or through special telexed warnings. The analysis will take account of the results of any aerial surveys and possibly some remote sensing products. The Information Officer will keep records of staff location and movements, and pesticide location and usage. The Information Officer will discuss the situation with the Head of the Unit, or if he is absent, the Senior Field Officer daily. The senior officer of the Unit present in Khartoum will inform the Head of the Locust and Grasshopper Section of any significant development.

If control is in progress the Information Officer will keep records of control activity including aircraft and spray monitoring locations.

The officer in charge of a base will be responsible for most field surveys in his sector and for sections of a large campaign. He will also be responsible for equipment assigned to his base, including vehicles.

The Administrative Officer will provide support to field staff in personnel matters and liaise with appropriate sections of PPD with regard to procurement. He will keep records of expenditure under the locust budget.

The spray machinery officer will maintain and service all PPD spray equipment not merely that assigned to the Unit.

The Head of the Unit will be responsible for all

aspects of the Unit's operation and will himself take charge of the operation of all major control campaigns. He will be responsible for the standard of survey and control.

4.3 Prosecution of Control Campaigns

These will be organized and directed by the Head of Unit. Aircraft supply will be authorized by the Head of the Locust and Grasshopper Section, but deployment will be determined by the head of the Locust Unit. Secondment of other officers and vehicles will be carried out on the authority of the the Director of PPD following the declaration of an Emergency by the Minister of Agriculture.

4.4 Field Testing of Pesticides

Approximately 1 ton of the appropriate formulation of promising ULV pesticides will be obtained and field tested as opportunity occurs. The tests are likely to take the form of well monitored ground application carried out under operational conditions.

4.5 Testing of Vehicle Mounted ULV Sprayers

Prototype sprayers now available will be field tested especially for robustness and ease of operation. A progressive attempt will be made to standardize ULV spray machinery for locust and grasshopper control.

4.6 Execution of Proper Methods of Control Application

ULV control needs to take account of:

1. weather conditions, especially wind;
2. the type of target; and
3. the size of target in relation to swath width.

Officers carrying out or directing spray operations must also understand the way in which the

speed of the aircraft, vehicle or man on foot, the emission rate and the track spacing determines the optional area dosage. The proper methods will be covered in training courses, and reinforced by on-the-job training.

Records of pesticide for locust control and equipment assigned to the locust unit, both quantity and location, will be maintained by the Unit's Administrative Officer. The record of pesticide issue will be the responsibility of the Regional Pesticide Stores Officer but the Unit officer at the appropriate base will make regular physical checks of the stock of locust pesticide held. The Administrative Officer will make at least an annual tour to carry out a physical check of all Unit stores and equipment.

4.7 Safety

Particular attention will be paid to instruction in, and implementation of, sound safety procedures in handling and application of pesticide by Unit staff and seconded officers. Safety will be a major feature of all training courses. It will be the responsibility of every officer to see that those under him behave in a sensible way. The Head of Unit, through the Administrative Officer, will ensure that the necessary equipment and clothing is available.

5.0 Outside Linkages

5.1 Steering Committee

In response to the threat of locust emergencies in 1986, the major donors and the GOS formed a Steering Committee whose job was, and is, to coordinate donor efforts and campaign work. Out of this Steering Committee grew the initiative for the Medium Term Locust Control Project designed to strengthen PPD's ability to respond to an emergency and to be able to sustain its normal survey and control activities during a recession period. Over the past years, this Steering Committee has been most effective in providing an interactive forum for policy guidance and problem solving. Membership is as follows:

GOVERNMENT OF SUDAN	DONORS
Undersecretary / MFEP	USAID
Undersecretary / MOANR	EEC
Ministry of Defense	FAO
Chairman / RRC	Dutch
Head PPD	DLCO

Under the project, the FAO Chief Technical Advisor and the head of the Locust Unit will also become members of the Committee.

5.2 Task Force

From the Steering Committee a smaller Task Force, responsible for day-to-day execution, was formed. This originally consisted of the head of the Locust / Grasshopper Section and the FAO representatives.

Under the project, terms of reference for the task force will be revised to include the head of the Locust Unit, as well as FAO long- and short-term technical personnel.

5.3 Role of DLCOEA

The charter of the Desert Locust Control Organization for Eastern Africa (DLCOEA) requires it to assist the national units of member states at times when the locust situation, especially the desert locust situation, is beyond the resources of the national unit. DLCO is supported by all the countries of Eastern Africa, from Sudan in the north, south to Tanzania. Sudan's contribution for the 87/88 fiscal year was 7% of the total budget of $4,520,000 or $689,300. This is paid in hard currency.

In addition, DLCO has 44 vehicles in the country, all of which are operated out of the PPD budget (It has been estimated that 25 of the vehicles are inoperative).

Sudan is an exceptional case in terms of DLCO assistance. In other member countries, DLCO is almost solely relied upon for control, which is outside its mandate to assist the national units. In Sudan, however, DLCO has very little role in control, due to the strong organization of the PPD.

However, DLCO has, of late, had insufficient

operating funds to supply aircraft and insecticide to meet all the calls upon its resources. Experience suggests that the amount of help that can be relied upon from DLCO is limited. It is hoped that DLCO will be able to make aircraft available provided support costs are met for future desert locust campaigns. DLCO may be able to provide technical advice and assistance, especially in the evaluation of ground sprayers, and that would be welcome. However, as with aircraft, it would be unwise to assume that DLCO will be able to help unless the additional costs are covered.

5.4 The Implementing Agency

In early 1986 the PPD turned to the Food and Agricultural Organization (FAO) of the United Nations for financial and technical assistance to control the desert locust and very heavy grasshopper infestations.

FAO/Rome organized several technical and multilateral meetings to raise funds for a concerted locust and grasshopper emergency control campaign throughout Sudano-Sahelian Africa in 1986. Several donors contributed to the FAO emergency project in Sudan.

Two major donors, USAID and the EEC, contracted with FAO/Rome for a joint operation to assist the PPD. The Netherlands and Sweden soon joined in and negotiated the transfer of their funds from FAO into a joint donor account.

FAO's involvement in the project will continue with the dual purpose of strengthening the international approach to fighting the long term locust threat, and of deriving the maximum benefit from the expertise of the Emergency Locust Control Operations (ELCO) of FAO/Rome. This involvement will keep the desert locust threat to Sudan on an international agenda where it belongs, rather than on an isolated national agenda.

With multilateral grant funds, FAO will procure services and commodities for the project. The project will finance FAO recruitment of long and short term advisors for the Locust and Grasshopper Section of PPD to establish the Locust Control Unit. FAO/Rome will handle procurement of pesticides through its Procurement Division. Terms of reference for the Technical Assistance team are attached as appendices to this Annex.

14/9

6.0 Sustainability/Organizational Issues

Sustainability is defined here as the ability of a government or organization to maintain a normal level of operations after the dispersal of all donor funds.

Some of the more commonly mentioned problems with projects are:

(a) utilization of inappropriate technologies;
(b) inflationary impact on local factor costs (especially labor);
(c) inappropriate project scale;
(d) inadequate attention to post-project budgeting;
(e) underestimation of the time required for project execution.

We would add a final consideration: volatility of the local political situation. There is a good bit of political instability in Sudan at present that may preclude locust control activities in certain regions. We will not address in this context the economic sustainability issue, this is done in the Financial Analysis. Suffice it to say here that the project will not create additional costs to GOS.

Since there are no new personnel slots to be filled, the impact on local factor costs will be minimal. The project has little, if anything, to do with land, or capital inputs.

The Technical Analysis shows clearly that the Medium Term Locust Control Project is technologically sound. There is little new technology to be introduced under the project, merely an institutional strengthening to allow for the more efficient use of the technological resources extant within the PPD.

The project is designed on an appropriate scale, utilizing existing human capital resources, and does not "graft" a new institutional structure onto PPD, but merely divides responsibility more clearly.

The time dimension has been adequately addressed as well. Three years is an appropriate amount of time for the on-the-job training and normal survey and control activities to become routine within the LCU. Since most staff will be familiar with their routine duties, it is perfectly adequate.

6.1 Administrative Sustainability

The creation of the Locust Control Unit as a separate part of the Locust / Grasshopper Section within PPD, with a separate budget, is a major step forward in the establishment of sustainable levels of

survey and control. The Unit was formed in July, however, and the head of the Locust Control Unit has yet to be named. PPD has requested for the next fiscal year a separate budget for the Locust Control Unit.

The issue of institutional jealousy has been raised above and some suggestions for avoiding it mentioned. It will involve both the head of the LCU and the head of the Locust / Grasshopper Section both being willing and able to travel often to the regional centers, and to coordinate with other control activities. Plans to train officers from other sections and from the other regional offices should go a long way towards raising awareness of the differences between locust control and normal crop protection activities. Training is an important component in creating an awareness of the national and international implications of the locust problem, and should go a long way in creating internal cohesiveness, not only for the LCU, but for the PPD as a whole.

There is not a substantial alteration of the structure of PPD. In point of fact, the establishment of the LCU within PPD makes for a more efficient chain of command than at present. Survey reporting will be considerably speeded up, as radio messages can go directly from the field to headquarters, without the necessity of having the approval of the Regional Entomologists, who are, themselves, frequently in the field.

The improvement of the information system should have positive impacts at all levels, including on the international and regional level.

6.2 Logistical and Management Considerations

FAO/Rome will utilize its established procedures to procure commodities and services to support locust control activities, including pesticides, technical assistance, etc. EEC procurement will be through FAO/Rome, regulations permitting, or through its commercial agent, Luxconsult.

Under the project, pesticides will be made available for campaigns as needed, to augment the one-month supply sufficient to treat a heavy infestation that will be maintained in-country. One should not, however, underestimate the amount of time needed to ship (by air) and clear pesticides from the airport. Experience has shown that this can take a minimum of two weeks. One possibility to reduce this time would be emergency regulations for clearing, which would allow goods to be moved quickly through the long bureaucratic clearing process.

The provision of a local hire admin. logistics

officer under the TA portion of the project should make liaison with appropriate departments within PPD go much smoother, and will help in expediting materials handling considerably.

7.0 Conclusions

The proposed reorganization of the Locust/ Grasshopper Section will substantially improve PPD's ability to perform its mission of locust control. The LCU will improve performance through a more concentrated chain of command and control.

The project had been determined to rely on appropriate technology, to have no inflationary impact, to be designed on an appropriate scale, and be planned within an adequate time frame.

It is the conclusion of this annex that project activities and organization are appropriate and institutionally sustainable.

ANNEX H

ENVIRONMENTAL ASSESSMENT OF THE SUDAN LOCUST CONTROL PROJECT

650 - 0087

United States Agency for International Development

Mission to Sudan

Khartoum, Sudan

August, 1988

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AID/W	Agency for International Development, Washington
CFR	U.S. Code of Federal Regulations
CICP	Consortium for International Crop Protection
DLCOEA	Desert Locust Control Organization for Eastern Africa
EA	Environmental Assessment
EEC	European Economic Community
EPA	U.S. Environmental Protection Agency
FAO	Food and Agriculture Organization
GOS	Government of Sudan
IPM	Integrated Pest Management
L/G	Locust and Grasshopper
MOANR	Ministry of Agriculture and Natural Resources
MOFEP	Ministry of Finance and Economic Planning
PEA	Programmatic Environmental Assessment
PPD	Plant Protection Department
RRC	Regional Rehabilitation Commission
TA	Technical Assistance
TAMS	TAMS, Inc.
ULV	Ultra Low Volume
UNESCO	United Nations Educational, Social and Cultural Organization
USAID	Agency for International Development, Khartoum, Sudan.
WHO	World Health Organization

1.0 Executive Summary

USAID/Sudan intends to develop and implement a project to strengthen the capabilities of the Government of Sudan (GOS) Plant Protection Department (PPD) to predict and control locust and grasshopper outbreaks and to develop a structure within PPD for the safe handling, storage and use of pesticides. USAID's assistance in this multi-donor Medium Term Locust Project will be in the form of provisions of pesticides and technical assistance for the Core Locust Control Activity and decontamination and destruction of pesticides and contaminated soil in the Pesticide Disposal Activity. This assistance will contribute to increased food availability by establishing the institutional capacity of the GOS to effectively implement locust and grasshopper control activities and to maintain safe handling, storage and use of pesticides.

The Environmental Assessment (EA) was prepared as a critical element of the project design, in compliance with AID's environmental procedures at 22 CFR 216. The EA identifies and analyses the environmental and health/safety issues of the proposed projects. The Programmatic Environmental Assessment (PEA) of Locust and Grasshopper Control in Africa and Asia (TAMS/CICP, 1988) forms the technical basis for the findings and recommendations of the EA, including a determination of the scope of the technical and policy issues to be examined in assessing the environmental impacts of large-scale use of insecticides for control of locust in Sudan (2.0 and 3.0). As the Medium Term Locust Control Project also includes the Pesticide Disposal Activity, this is a phased EA, and this portion deals only with the Core Locust Control Activity. The EA will be amended in the future to include the disposal activity.

After careful analysis of the alternatives for control, it was determined that a chemical program utilizing primarily ULV insecticides applied in a judicial and well managed program is the most efficaceous, economical and environmentally sound approach.

Provisions have been made within the design of the project and the EA for control activities to have the least possible adverse impact on the environment, taking into account currently available control methods. However, it is recommended that research continue on alternative means of control. Biological

control methods are currently being researched on a regional basis in Northern Africa. If these methods prove to be viable, they should be incorporated into the project.

Due to its previous good results in Sudan, Fenitrothion will be the primary insecticide used initially in the Medium Term Locust Project. Alternatives such as Malathion, Carbaryl, Chlorpyritos, Bendiocarb, Lambda-cyhalothrine and tralomethrine will be introduced and field tested to gain experience with their use (6.1). These recommendations are subject to final approval of the L/G PEA (TAMS/CICP, 1988).

Sudan is a large country with a very diverse environment. The majority of the locust outbreaks take place in the northern two-thirds of the country. Included in this area are several national parks, refuges and sanctuaries. These institutions must receive detailed consideration before a decision is made for locust control in or near their boundaries (5.2 and 5.3).

Through the efforts of the multi-donor Medium Term Locust Control Program and the efforts of the GOS, PPD, an active, viable and responsive Locust Control Unit will be established. This Unit will be able to function independently in times of recession and expand to meet the needs in times of emergency. Throughout the Medium Term Project, the Unit will be enhanced by Specialized Technical Assistance provided by FAO.

Regional environmental mitigation measures under this project include provisions for technical expertise in the areas of environmental monitoring, pesticide safety and health. Mitigation methods also include special procedures for locust control in ecologically sensitive areas. Physical procurements will include test kits and supplies for cholinesterase monitoring.

2.0 Purpose of Assessment

2.1 AID Environmental Procedures

It is AID policy to ensure that the environmental consequences of AID-financed activities are identified and considered by AID and the host country prior to a final decision to proceed and that appropriate environmental safeguards are adopted (AID 1980). This policy is embodied in the legal requirements set forth at Title 22 of the Code of Federal Regulations, Part 216, "AID Environmental Procedures" (22 CFR 216). The EA for the Sudan Medium Term Locust Control Program is based on the requirements of 22 CFR 216.

2.2 Programmatic Environmental Assessment for Locust Control

In early 1987 AID/W initiated a number of activities related to implementation of its commitment to the use of environmentally acceptable pesticides in locust and grasshopper (L/G) control programs in Africa and Asia, including preparation of a PEA per 22 CFR 216.6 (d) of L/G control in Africa and Asia; and staging of field testing programs to study the efficiency and environmental impact of certain pesticides for the control of locusts and grasshoppers in Africa (AID, 1987). Reports resulting from these activities were available at the time of preparation of this EA, and provided the technical background for many of the findings and recommendations contained herein.

2.3 Sudan: Environmental and Pesticide Legislation

A global environmental legislation in Sudan is non-existent up to this date. Certain legislation concerning the different environmental components are present in a general form especially in the punitive section where violation on forests, water, sanitation, etc. are being discussed and indemnities are set.

The first legislation ever to be set by the PPD was that established in 1920. Evidently, pesticides were not used then and it concerned organizing the population for manual control of grasshoppers/locusts. It also punished farmers for not announcing the presence of swarms in their localities.

The pesticide legislation in Sudan was drafted in 1974. This Act is entitled "The Pesticide Act of 1974", and deals wholly with registration, manufacturing and importation of pesticides. An amendment to this law has been drawn in 1987 enlarging the parts concerned with trade and distribution of pesticides.

A draft Environmental Law is presently undergoing revision by assigned personnel in the Attorney General's Office whereby a global law for the protection of the environment is sought.

3.0 Scoping Procedure

AID/W Environmental Procedures at 22 CFR 216.3 (a) (4) describe the scoping process to be employed in identifying the significant issues related to a proposed project and determining the scope of the issues to be addressed in the environmental assessment. Critical elements of the scoping process include : a determination of the scope and significance

of the issues to be analyzed in the EA, an identification of and elimination from detailed study those issues that are not significant or have been covered by earlier environmental review.

Due to the uniqueness of this project, that being its separation into two parts, Core Locust Control Activity and Pesticide Disposal Activity, this will be a phased EA which will allow for functional separation of the Core Locust Control Activity from the Pesticide Disposal Activity. While the two activities can be interrelated (certainly training aspects), one activity should not depend on the other, especially for schedule and implementation. The Pesticide Disposal Activity takes care of the immediate problem, and USAID's portion of the Core Activity helps prevent the problem from recurring.

The process of identifying the technical and policy issues applicable to control of large scale locust outbreaks which require detailed environmental review was performed during preparation of the L/G PEA (TAMS/CICP, 1988) and will not be repeated here. The principal Sudan-specific issues requiring detailed examination are treated in the Environmental Assessment of the Action (Sec. 6.0). The Core Locust Control Activity is composed of three distinct yet interrelated subactivities : a) Technical Assistance, b) Training and c) Commodities. In addition there is a contingency for hiring aircraft. Each will be discussed from the perspective of its environmental implications.

In accordance with Cable #/12159 Nairobi, dated 4/29/88 from REDSO Nairobi to B. Boyd, AFR/TR/PRO the EA for the Core Locust Activity will be essentially a desk analysis from existing secondary data assisted by minor field data. Analysis and discussion of the environmental impacts contained in the Core Locust Section of the EA are derived from meetings held both with the public and private sector of interested parties in the Sudan and from review of existing literature.

4.0 Proposed Action and Alternatives

4.1 Background

Locusts and grasshoppers have infested all of the Sudan with the exception of the southern provinces of Bahr Al Ghazal, Al Buhayrat, Upper Nile, Jonglei, and Western and Eastern Equatoria. Sudan is a preferred breeding area for the desert locust (Schistocerca gregaria). Uncontrolled infestations of this species in the Sudan could promote widespread crop devastation throughout Africa and Southeast Asia. A periodic pattern of upsurges (high activity) and recessions (low

activity) are characteristic of this species. Those upsurges are primarily due to rain, occurring during the return to normal rain after an extended period of drought or a sequence of good rains that link breeding areas. Thus in the Sudan following the 1983-85 drought, adequate rains in 1986 allowed for severe grasshopper and locust activity.

The recent upsurge of locust and grasshoppers in the Sudan began in 1985. A threat of major infestations of desert locust in Sudan from the west was present in 1986, which resulted in swarm breeding late in the summer. Swarm breeding continued in 1987 on the Red Sea coastal plains. Containment of these swarms was generally accomplished, however, breeding on the Eritrean coastal plain was not adequately contained. Summer breeding in 1987 was noted in the west of Sudan and adjacent parts of Chad. This was followed by a second generation, which was larger and on a wide scale. The major threat of desert locust in 1988 to Sudan will likely be from the west, as uncontrolled swarms from neighboring countries enter the Sudan for summer breeding activities. In addition to the locust infestations, Sudan suffered severely from grasshoppers both in 1985 and even more in 1986. Decreased infestation levels and damage was noted in 1987.

The Government of Sudan's PPD is charged with locust and grasshopper control activities. During the 1986 locust upsurge, the PPD was unable to mount an effective and rapid control program once indications of the potential locust outbreak were noted. Many reasons can be stated for this, but the major fault lies in PPD's lack of adequate amounts of resources, (i.e. pesticides, vehicles, pesticide application equipment and aircraft), trained personnel and adequate communications between the field and headquarters. Although the GOS made request for assistance to the Desert Locust Control Organization for Eastern Africa (DLCOEA) of which they are a member, the response was too little and too late. DLCOEA's insufficient operating funds and bureaucratic procedures are noted reasons for this problem.

In 1986 the GOS made an international request for assistance,this resulted in a multi-donor emergency locust control campaign. Principal financial donors to this request were USAID, the Netherlands and the EEC. Although this effort was not 100% successful, it did provide that equipment and sufficient amounts of insecticides were delivered to Sudan and were distributed to field stations to undertake the required control measures. It also provided for continuous monitoring by FAO consultants and through the campaign steering committee members to ensure that the PPD

continued to receive necessary technical and administrative support to implement its programs.

Various assessments conducted during the emergency campaigns in 1986 and 1987 revealed that the efforts of PPD were continually hampered by unsafe pesticide handling and storage, inappropriate pesticide application practices, poor accountability in the distribution and movement of pesticides and substantial stocks of outdated pesticides in PPD stores. Pesticides often are hazardously stored, with substantial container seepage on the ground. PPD pesticide stores are in poor structural condition and are placed nearby residential areas, creating serious threats to health and safety of residents and workers.

The poor pesticide safety and management in PPD stores is exacerbated by the irrigated agricultural sector which imports large quantities of cotton pesticides each year, and passes on old, outdated, and excess stocks to the PPD. The PPD is not in a position to refuse any of these donations, as they receive very little in the way of pesticides, being reliant on the severely strained GOS annual budget. As a result, PPD stores are often crammed full of old cotton pesticides. The efforts of the World Bank to rationalize pesticide management on the irrigated schemes will contribute significantly to a reduction in pesticide accumulation in the PPD stores.

During February 1987, a multi-donor team representing AID, the Netherlands and EEC developed a strategy to support PPD's 1987 emergency needs and medium term requirements through 1990. The main thrust of the plan was to treat locust and grasshoppers separately, with the former being the responsibility, except in emergency, of a small locust unit within the existing Locust and Grasshopper Section of PPD. The plan proposes that, given the periodic nature of major infestations, actions taken during the next few years are critical to both: 1) the containment of the current emergency, and 2) the reinforcement of Sudan's PPD to cope with the long-term control and management of pests. This plan is the basis for the Multi-donor Medium Term Locust Control Project and continued emergency donor support to the PPD. The plan stipulates:

1. Building upon the control and survey activities (and lessons learned) by Sudan and donors in the 1986 emergency program; and
2. Expanding and enhancing those activities in the next few years in order to:
   a). establish standards and criteria for determining when and where to apply strategies for control of the pests;

b). provide needed resources (technical, financial, and material) for timely efficient (and cost-effective) pest survey and control activities, that fully take environmental concerns into account; and

c). train and develop a Sudanese human resource base that can help to reassert and, subsequently, maintain control of the threat posed by locusts and grasshoppers.

Based on this assessment and continued locust activity in 1987, donors maintained emergency support for the PPD through locust summer breeding season in 1987 to mid-year 1988. Experts anticipated that, based on the number of locusts that may have survived in various areas, within and outside Sudan, the 1987 breeding season would be even more severe than the 1986 season. On the other hand, grasshopper infestation levels were likely to decline somewhat. Unless desert locust control activities continue to be organized quickly and efficiently, Sudan could face a continuation, or even an increase in the intensity of locust infestations in the next few years.

The importance of locust control in Sudan is well-recognized by international experts due to the potential invasion area of the desert locust and subsequent crop devastation posed within and beyond Sudan's borders. Sudan is gradually recovering from the devastating drought and famine of 1983-85. Harvests in 1985 and 1986 were above average, with encouraging signs that many traditional farmers were regaining self-sufficiency in 1987. Furthermore, many donors are supporting increased agricultural production through research and introduction of improved varieties of sorghum and millet. These trends and development activities can only continue if the locust threat is controlled, and optimally prevented, for a plague of locusts can easily destroy the hard work of farmers and researchers alike.

4.2 Project Goals, Purpose and Output

The goal of the project is to contribute to increased food availability by establishing the institutional capacity of the GOS to effectively implement locust and grasshopper control activities and to maintain safe handling, storage and use of pesticides. The purposes of the project are twofold:
1) to strengthen the capabilities of PPD to predict and control locust and grasshopper outbreaks, and
2) to develop a structure within PPD for the safe handling, storage and use of pesticides.

The objective of this project will be achieved through the implementation of four discrete but mutually reinforcing activities:

1. establishment of a core Locust Control Unit,
2. pesticide disposal
3. pesticide stores rehabilitation
4. stores stock control procedures improvement.

1. Establishment of a Core Locust Control Unit

The objective of this component is the creation of a Core Locust Survey and Control Unit comprised of highly trained and motivated PPD staff capable of carrying out:

a. all locust surveys
b. ground control at times of minor activity
c. direction and supervision of both ground and aerial locust control in periods of greater activity.

The creation of the unit will not involve the recruitment of new personnel, but will entail the reorganization of qualified personnel within PPD and the Grasshopper and Locust Section, specifically. The unit will consist of a chief officer, information officer, administrative officer, spray machinery mechanic, an officer-in-charge for each of five field bases, and five field officers.

The Unit will seek to accomplish the following tasks, in addition to the survey and control of locusts:

a. Develop and test methods of ground control and test ground spray equipment.
b. Establish threshold levels justifying control of grasshopper infestations in different crops at various stages of plant and insect development.
c. Develop an improved local information service for locust reporting both within Sudan and the surrounding region.
d. Train regional entomologists and their technical staff in fundamentals of locust control, in methods of ground control and in the role of both the Unit and Regional Staff during a major locust campaign.
e. Keep records of stocks and usage of all equipment and supplies, especially pesticide designated for locust control.
f. Identify and use improved methods of ULV ground control for both locusts and grasshoppers.
g. Incorporate the practice of proper methods of pesticide application for both locusts and grasshoppers, taking into account type of target

and weather conditions, and the need for the application of an accurate area dosage.

2. Pesticide Disposal

The project will finance the disposal of large quantities of outdated pesticides and other chemicals currently stocked in PPD pesticides stores. Three methods have been identified as disposal options within Sudan: incineration, cement kiln and landfill. By project completion, all outdated pesticides in PPD stores and contaminated earth should be properly eliminated. This disposal will result in the clean-up of contaminated storage areas and the surrounding environment and the availability of additional storage area in PPD stores. An additional outcome will be the heightened awareness and participation by the appropriate GOS ministries in the control of pesticides in the Sudan.

An indirect but expected accomplishment under this project component will be a follow on project by the World Bank to clean up and destroy pesticide waste on the irrigated agricultural schemes. A reduction in pesticide imports by the schemes will have a spin-off effect, reducing the amount of chemicals dumped on the PPD stores.

3. Rehabilitation of Pesticide Stores

The project will finance the rehabilitation, relocation or new construction of PPD pesticide stores according to acceptable safety and health standards. The creation of safe, properly located and constructed storage facilities will result in reduced health risks to workers and adjacent communities. This portion of the project is being conducted by the Netherlands.

4. Improvement of Pesticide Stores Stock Control Procedures

The activities of this component will address the inefficient and unsafe stock control practices currently utilized by PPD. Through this component an inventory control system, which incorporates procedures to ensure safe minimum stock levels, safe handling, storage, distribution and accountability for pesticides, will be introduced and incorporated into PPD stores operations. This portion of the project will also be conducted by the Netherlands.

1.5x

End of Project Status: By project completion, the following conditions should exist within PPD:

- PPD will be implementing improved recession surveys for desert locusts, especially during the summer months.
- PPD will be organized to mount quickly a large locust campaign at short notice, using aerial ULV pesticide spray methods.
- PPD will be utilizing improved labor intensive ground control operations in times of upsurge.
- PPD will be utilizing a reduced quantity of liquid pesticides in locust control through better application methods.
- PPD will be effecting a reduction in cost of locust control due to use of appropriate pesticides and application rates.
- PPD will be implementing a cost-effective grasshopper control system
- Pesticide application health risk will be reduced to operators and bystanders.
- PPD staff will be correctly handling and storing pesticides according to acceptable safety and health standards
- PPD will be implementing a locust control program at acceptable minimum stock levels.
- PPD will be maintaining safely located and constructed pesticide stores.

4.3 Other Donor Activities

The Medium Term Locust Control Project will coordinate the assistance of three major donors, AID, the Netherlands and EEC, who supported the 1986 and 1987 emergency programs. The project duration is 1988 through 1991. The medium term assistance will be in the form of continued technical assistance, training, pesticide storage rehabilitation, and supplies. The technical assistance will concentrate on providing practical, on-the-job training in locust control for PPD's staff and improving PPD's management and organization. ODA and the Canadian Government are expected to provide financial support for discrete commodities.

The project is an umbrella project for four activities :

1) core locust control,
2) pesticide disposal,
3) pesticide stores rehabilitation and
4) pesticide stores stock procedures improvement.

The locust control component will be financed multilaterally and implemented under the auspices of FAO/Rome. Donors are expected to execute grant agreements with FAO/Rome and the GOS for the execution of this activity. The pesticides disposal component will be financed by AID and implemented by FAO under the core locust control agreement. The remaining activities will be financed and implemented bilaterally through donor agreements with the GOS.

-Core Locust Control: $5,915,000 (USAID, EEC, Netherlands, ODA, Canadian grants to FAO)
-Pesticide Disposal : $1,230,000 (USAID grant to FAO)
-Pesticide Stores Rehabilitation : $3,200,000 (Netherlands grant to GOS)
-Pesticide Stores Stock Procedures Improvement : $300,000 (Netherlands grant to GOS)

PPD of the Ministry of Agriculture and Natural Resources (MOANR) will be the principal implementing agency for all activities. All technical assistance (TA) personnel will operate under the direction of the Director of PPD. A project steering committee comprised of PPD, Ministry of Finance and Economic Planning (MOFEP), MOANR, Relief and Rehabilitation Commission (RRC), and the principal funding donors (EEC, USAID, the Netherlands) and FAO will advise PPD on project implementation and provide a forum for the discussion and approval of workplans, budgets and technical assistance.

PPD implemented the 1986 and 1987 emergency campaigns under close direction of the Locust Control Steering Committee, which convened weekly. The Steering Committee operated through a Task Force for the preparation of terms of reference, budgets and workplans. The task force was comprised of the FAO Team Leader; the Head of the Locust Section, PPD; Royal Netherlands Embassy; USAID; and EEC.

The composition of the Task Force under the Medium Term Project will be revised to include the Head of the new Locust Control Unit of PPD, and medium and short term expatriate expert assistance to the project.

The Medium Term Project has been developed under the close direction of the Steering Committee. Given its intimate relationship with the project, the Steering Committee (which will continue for the purpose of the project) will maintain essentially the same terms of reference as in the 1986 and 1987 emergency programs. An additional role of the Steering Committee will be to assist the PPD in requesting assistance from the DLCOEA, which is to assist national locust control units during locust emergencies.

4.4 Analysis of Alternatives

There are five possible technical alternatives that AID considers for locust and grasshopper control. They are as follows:

A. No action
B. Non-chemical control (i.e. mechanical destruction or changes in cultural practices)
C. Biological control
D. Chemical control
E. Integrated pest management.

The L/G PEA (TAMS/CICP, 1988) deals in detail with these alternatives. Their analysis of these alternatives includes economic analysis; short, medium and long term actions; environmental impact, effectiveness and training and research requirements. The alternative analysis concluded that:

The technical alternatives are theoretical rather than actual. There are, at the present time, only two alternatives - that of taking no action, or of mounting a control effort using chemical controls. If control is chosen then the technical alternatives really come down to different approaches within the chemical control operation: either that of large scale spraying of extensive areas, as was adopted in the Africa grasshopper campaign of 1986, or more selective spraying of carefully targeted outbreak areas. The latter presents the less potentially harmful environmental consequences, as well as being the more cost-effective approach (L/G, TAMS/CICP, 1988).

This analysis well represents the situation in Sudan. The alternative of "No Action" has three distinct negative results; economical, political, and environmental. Judicial use of selected insecticides in a well managed and technically sound program is the clear action to be taken and will be addressed by this EA.

Although biological control would be useful and preferred in addition to the use of insecticides, at the present time, the use of these agents has not proven to be successful in desert locust control. Research is currently under way in the form of a regional project. As this procedure is refined and when it is proven to be effective, it should be incorporated into the project. The procedures would then include a combination of chemical and biological control methods to create a true integrated pest management project.

4.4.1 Economical

Analysis done for the Project Paper indicates that about 2,000,000km^2 in Sudan are potentially susceptible to attack by desert locust. It is estimated that, within this area, from 1 - 15% of the food crops (which make up about 90% of total area cultivated in Sudan and account for 80% of the value of all crops) could be destroyed. A medium infestation could threaten crops worth $20,000,000 in a season. Half of this ($9,000,000 - $10,000,000) could be saved by an efficient control program. Savings in years of heavy infestation would probably amount to $20,000,000 or more in Sudan alone. When the locust problem is considered on a regional basis, the results of the "no control" option may result in plague infestations and the avoidable damage would be in the hundreds of million dollars per year.

4.4.2 Political

USAID has been intimately involved in locust/grasshopper control for many years. It has established itself as a lead agency in these programs, and is respected both by the host countries and the other donors. To turn its back on this situation could cause AID difficulties in programs not related to locust/grasshopper.

The regional ramification of a "no action" decision would also be widely felt. Control of locust is not a single country effort, as locusts know no borders. For Sudan not to make an asserted attempt at controlling the locust within its borders would undoubtedly add to the control problem across that of Northern Africa.

4.4.3 Environmental

From an environmental point of view, the decision for USAID to not remain involved in locust/grasshopper control could be devastating. USAID has been the leader in the push to eliminate the use of more toxic insecticides and initiate the use of less toxic insecticides. For USAID to back out now could allow for the re-entry of those banned insecticides into control programs. As we look into the future at the possibility of biological control and integrated pest management, again USAID will be the leader. Thus providing needed technology for the future control measures used in these types of programs.

5.0 Environment to be Affected

The Republic of Sudan covers an area of approximately 2,506,000km^2 in northeast Africa. The country spans three major African ecological zones: desert, semi-desert and savanna. The northern half of Sudan is classified as arid to hyperarid by UNESCO (1977). Most of the rest of the country ranges from semiarid to subhumid in UNESCO's classification. Only the southwest corner does not suffer from any significant moisture deficit. Sudan has few highland areas, and most of these are found on the fringes of the country. Several geophysical regions are usually distinguished, based on a combination of climatic zone and topography. They include:

1. Northern Desert region which is nearly uninhabited except for the densely populated Nile Valley which runs through it.
2. Plains include most of the country outside the mountainous regions, the Nile Valley and the northern desert region.
3. Mountains include Jebel Marra in Darfur (3,100m), Mt. Kinyeti on the frontier with Uganda (3,200m), the Red Sea Hills range from between 2,200 to 2,700m and Jabel An-Nuba (1,400m). The Red Sea Hills are arid and inhospitable to human settlement. The Jebel Marra and J. Nuba regions are somewhat better watered and support sedentary agriculture.
4. The Sudd swamp region of south Sudan is sometimes distinguished separately, as is the Nile Valley.

5.1 Human Population

The population of Sudan is quite diverse, with over 100 recognized languages. The population is largely dependent on agriculture, and concentrated to a large degree in the Nile Valley. There are also relatively (by Sudanese standards) dense population concentrations in Southern Kordofan, Western Darfur, Southern Blue Nile and Northern Bahr El Ghazal. Population distribution is delimited approximately by the northern limit of the 350mm rainfall isohyet, and most probably soil type as well.

The total population is estimated at about 23 million people, with the vast majority dependent on agriculture for their livelihood. There is a relatively large transhumant population, with most of these groups located in the Red Sea, Darfur, Kordofan and Blue Nile regions. The Nile Valley, however, is the most developed agricultural region in terms of infrastructure, and depends largely on irrigation of

one type or another. The Central Region is given over to vast irrigation schemes, including the infamous Gezira scheme.

The Western regions, however, where traditional agriculture is the dominant mode of production, probably is responsible for about 50% of value added in agriculture (Riley, 1983). The southern and northern regions are culturally distinct from the Nile Valley (Doornbos, 1983 and 1985; Akwoyer, 1985; and A/Rahman Abakir, 1985). The Southern region is separated geographically by the Sudd and the Bahr El Arab.

Beginning in 1983, armed conflict between southern factions and the government in Khartoum has essentially removed the southern Sudan from any productive economic role in Sudanese society. The rebels control vast areas of agricultural importance, and have essentially put a stop to projects of potential national economic importance, including oil exploration and the Jonglei Canal, which was intended to increase the flow of the Nile. The latter has become an issue of some seriousness for Egypt.

5.2 Parks, Reserves and Sanctuaries

Sudan used to have eighteen protected areas for wildlife (Cloudsley Thompson, 1973). These include national parks where all human activities are prohibited; game reserves for the protection of certain animals and plants and sanctuaries for small mammals but mainly for birds. Unfortunately, the present legislation on wildlife and national parks (Wild Animal Ordinance of 1935, amended 1986), is not adequate to preserve what remains. Conservation in all protected areas in Sudan is unsatisfactory and some game reserves and sanctuaries are no longer worthy of their names because all game animals have disappeared from them and their natural habitat has been destroyed (Nimir and Hakim, 1979). All protected areas are administered by the Wildlife and National Parks Conservation Forces, Ministry of Interior. In the regions that are embraced within the Locust Control Project are found two national parks, two game reserves and three sanctuaries (Fig.1).

5.2.1 Dinder National Park

The park lies 406km southeast from Khartoum, near the Ethiopian border in the Blue Nile Province. Established in 1935, it now covers an area of about 3,000 square miles. The park receives an annual rainfall of 600-1000mm between June and November. The Dinder and Rahad rivers flow between June and October. Natural surface water is only found in sporadic pools

in the river bed and in some mayas (wet meadows). Most of the park seems to fall within the Acacia seyal - Balanites savanna alternating with grassland zone. The fauna of Dinder National Park is rich and diversified. The following big mammals are now present in the park (Hakim, 1984):

English Name	Latin Name
1. Reedbuck	Redunca redunca
2. Tiang	Damaliscus korrigum
3. Oribi	Ourebia ourebi
4. Waterbuck	Robus defassa
5. Buffalo	Syncerus caffer
6. Warthog	Phacochoerus aethiopicus
7. Roan antelope	Hippotragus equinus
8. Giraffe	Giraffa camelopardalis
9. Gazelle	Gazella rufifrons
10. Bushbuck	Tragelaphus scriptus
11. Kudu	Tragelaphus strepsicerus
12. Baboon	Papio anubis
13. Monkey	Erythrocebus patas
14. Lion	Panthera leo
15. Leopard	Panthera pardus
16. wild dog	Lycoon pictus
17. Hyena, spotted	Crocuta crocuta
18. Hyena,striped	Hyaena hyaena

Also present are the gray mongoose (Herpestres ichneuman), porcupine (Hystrix sp.), several cat (Felis servai), wild cat (Felis libyca) and honey badger (Mellicrora capensis).

Dinder National Park is blessed with rich bird life. Over 50 bird families are represented by more than 200 species. Some of the most common birds that can be seen in the park are (Hakim, 1984):-

English Name	Latin Name
1. Ostrich	Struthio camelus
2. Bustard	Ardeotis kori
3. Guinea-fowl	Numida meliagris
4. Marabou stork	Leptoptilos crumeniferus
5. Sudan dioch	Quelea quelea
6. Saddle-bill stork	Ephippiorhynchus senegalensi
7. Carmine bee-eater	Merops nubicus
8. Crowned crane	Balearica pevonina
9. Piod Kingfisher	Ceryle rudis
10. African fish eagle	Cuncuma vocifer

5.2.2 Radom National Park

This park lies on the southwestern corner of Southern Darfur Province on the boundary with Bahr El Ghazal Province. It is a recently established national park with elephants, giraffes, buffaloes, lions, leopards, hyenas, baboons, ostriches and others. This park is not likely to be affected by the Locust Control Campaign.

5.2.3 Tokar Game Reserve

Not far from the Red Sea, the Reserve was established in 1939 for the protection of flora and fauna. There is little information about it. Its area is reported to vary between 12,500 and 650,000ha. Ibex, a few gazelles, roan antelope, greater kudu and leopard were reported in US MAB (1981).

5.2.4 Rahad Game Reserve

The reserve was established in 1939 as a buffer area for the Dinder National Park, to house flocks of the soemmering gazelles in their northward rainy season seasonal migration. From 1960 onwards farmers from spontaneous villages along the river trespassed the reserve leading to a further assault on the remaining land by Gedaref farmers. The actual area is not known but the figure of 12,500ha has been reported. This is the only place in Kassala province where lions are still to be seen during the rainy season and where tree monkeys are still present with few stray soemmering gazelles and reedbucks (Younis and Abdella, 1987).

5.2.5 Sanctuaries

There are three sanctuaries in northern Sudan: Arkawit-Sinkat Sanctuary in the Red Sea Province, Sabaloga Sanctuary in Khartoum Province and Khartoum Bird Sanctuary. However, the status of game protection in these sanctuaries is little better than for reserves and little information is available about their wildlife. The wild sheep (Ammotragus lervia) and ibex (Capra ibex), for the protection of which the Sabaloga Sanctuary was established, are believed to no longer exist.

Also, game animals are found outside these protected areas. In the Red Sea Hills in particular Dorcas gazelle and ostrich are reported along the Red Sea Coastal Plains where swarm breeding was reported to have continued during the spring of 1987. Breeding on a substantial scale was expected to take place on the same area in the winter/spring of 87/88 and much of the interm of summer 1988. It seems, therefore, that the Eastern Region,and specially the Red Sea Coastal Plains, will be the theatre of major Locust/Grasshopper Control Operations.

5.3 Rare, Endangered and Migratory Species

A number of species have been listed by the IUCN Red Data Books (1978) as being either vulnerable or endangered. From this and another list (Younis, pers. comm.) the following species are considered endangered. (Animals in southern Sudan are not included):

1. Addax
2. Wild ass
3. Cheetah
4. African elephant
5. Slender-horned gazelle
6. Leopard
7. Scimitar-horned onyx
8. Wild dog
9. Tora hartebeest
10. Lord Dery's Eland
11. Tiang
12. Giraffe
13. Soemmering gazelle
14. Northern bald-headed ibis
15. Peregrine falcon

Migratory Species

In the Dinder National Park, some of the larger animals migrate to wet season habitats beyond the boundaries of the park. The migratory species include:

1. Tiang
2. Roan antelope
3. Giraffe
4. Ostrich
5. Singa gazelle

Migratory Birds

There are over 900 species of birds in Sudan, both resident and migratory. Some areas, especially in the eastern region of Sudan which have witnessed locust incidents, are routes for migratory birds, while other areas as breeding sites. The species of birds which occur in the breeding or migrating areas of desert locust and which are considered to be rare and endangered are :

1. White stork

2. Peregrine falcon

3. North bald-headed ibis

4. Bustard

5. Nubian vulture

5.4 Agricultural Resources

Sudan is overwhelmingly dependent on agriculture. While estimates are both vague and varying, it is safe to estimate that at least 90% of exports come from the agricultural sector, and that about 85% of the population is engaged in some form of agricultural production. According to MOANR figures, there are some 14 million feddans (1 feddan = 1.03 acres) or 5.7 million hectares under agricultural production (Zahlan, 1985 and D'Silva, 1985).

The agricultural sector is divided into four sub-sectors:

a. irrigated schemes
b. Rainfed mechanized
c. rainfed traditional
d. pastoralists

The first will not be dealt with here, as they are virtually autonomous entities within the agricultural sector.

5.4.1 The Mechanized Rainfed Sector

Beginning in the 1960's, the government made available land and other inputs to "merchant farmers". Varying in size between 1500 and 5,000 feddans, these plots are largely allocated to the production of sorghum, sesame and cotton. They are concentrated to a large degree in the Eastern Region, Southern Blue Nile and South Kordofan. There is very little control over land usage patterns, however, and the general practice is to farm the land (after clearing) for about five years, until yields fall, and then to request a new plot. Ford, Riley and others have shown that this is tantamount to "soil mining". Evidence gathered by USAID's BNIADP, however, has shown that this mining is probably related to the use of the wide-level disc plough, with a shallow ploughing depth, which causes a hardpan to form and subsequent problems with mineral buildup and water retention. There is also a serious problem with striga, a sorghum parasite. The abundance of land makes it more economical to merely get a new plot than to adopt proper agronomic practices. There are a number of unregistered farms (known as the undemarcated areas) in Sudan, so total production figures are unreliable.

5.4.2 The Rainfed Traditional Sector

There is virtually no accurate information about this sector, but it is a major contributor to the economy. Estimates of contribution are as high as 50% of the total value added in agriculture, but it is virtually impossible to estimate the economic returns to subsistence agriculture. This sub-sector, however, provides a living for the majority of Sudanese farmers. There is an enormous amount of production, and an active market for the food produced. Most subsistence farmers live in Darfur and Kordofan, away from the riverine regions. There are few "modern" inputs into this sector.

Many farmers depend on an informal credit system known as "sheil" for their operating capital. Like many risk-averse farmers all over the world, they are both unwilling, and unable, to invest in constant capital inputs. Farm size is delimited by available family labor to a large extent, and often constrained as well by the necessity of resorting to wage labor on the irrigated schemes.

There is an informal system of labor-sharing, through work parties known as nafir, but the relative

importance of this is little studied. Suffice it to say that the traditional rainfed sector is the backbone of the Sudanese economy.

5.4.3 Pastoralists

While this is an important sector of the economy, it is totally neglected for a variety of reasons. The exact nature of the contribution of the livestock sector is, frankly, unknown. The major reason for this is the unsettled nature of the transhumant activity. Another is the fact that livestock represents savings (i.e. deferred consumption) so that take-off rates are generally low. They are probably not as low as generally estimated, however.

In a somewhat perverse adaptation of the "fungibility factor" applying to agricultural inputs, livestock are smuggled into Ethiopia and to the Gulf States in unknown quantities. The Tchadian border is completely porous. A major impact on the pastoralist population has been the event of the mechanized schemes, which have disrupted traditional transhumant routes, and have, in the past, led to a great deal of friction between the scheme owners and pastoralists.

6.0 Environmental Assessment of Action

This assessment meets the format and content as defined in 22CFR 216.3 (b)(1) (AID, 1980). As stated prior in Section 2.2 of the document, the majority of the technical background for this assessment was done and reported in L/G PEA (TAMS/CICP 1988). Basic research on environmental effects and efficiency of this type of action has been initiated in field testing programs (Dynamac, 1988 Mali). Results of these reports will not be repeated in this document, rather references made to the reader for more detail. .pa

6.1 Selection of Insecticides for Locust/ Grasshopper Control

6.1.1 U.S.EPA Registration Status of Selected Insecticides and Recommendations of the L/G PEA

There is currently a USAID regional research project in progress to evaluate the efficiency and environmental impact of various insecticides in a

locust and grasshopper control program. The first of these trials was conducted by Dynamac in Mali on the Senegalese grasshopper Oedaleus senegalensis and reported in 1988. The second trial, again by Dynamac, was in Sudan in the spring of 1988. The efficacy portion of this trial was not conducted due to lack of sufficient locust to conduct a scientific trial, however, the environmental impact portion was completed. Results of this trial were not available at the time of this writing. Eight insecticides were selected for inclusion in these trials. The basis for selection of these insecticides was USAID's policy that any insecticide financed with USAID's funds for locust and/or grasshopper control must meet the following requirements:

1. US EPA registered
2. Established tolerance for at least one food crop (40 CFR 80), or meet the established daily intake level and maximum residue level recommended by the Joint Meeting on Pesticide Residues to the FAO/WHO Codex Committee on Pesticide Residues.

In consideration of the above stated guidelines, this assessment also takes into account the potential environmental impacts and efficacy as determined by literature reviews. The insecticides therefore chosen are listed below according to class.

ORGANOPHOSPHATES	CARBANATES	PYRETHROIDS
Malathion	Carbaryl	Lambda-cytralothrine
Fenitrothion	Bendiocarb	Tralomethrin
Chlorpyrifos	Propoxur	
Diazinon		

These eight insecticides were included in the review in the L/G PEA (TAMS/CICP, 1988). All were found, through the literature to be considered efficaceous toward locust or grasshoppers or both. The differences in the compounds lies in their effect on the environment, specifically, non-target organisms.

The following table gives the relative toxicity to select non-target groups which are of importance in the Sudan.

CHEMICAL	BIRDS	MAMMALS	FISH	AQUATIC INVERTEBRATES
Malathion	M	L-M	L	L
Fenitrothion	H	L	L	H
Chlorpyritos	-	M	L-M	H
Diazinon	M-H	L	M	H
Carbaryl	L	L	L	L
Bendiocarb	M	M	M	M
Lambda-cytralothrine	L	H	H	H
Tralomethrin	L	L	H	H

L = Low; M = Medium; H = High

As the above table indicates, in different environmentally sensitive areas, one or more of the insecticides would have an advantage. These properties should be taken into consideration when selecting the insecticide to be used. As has been stated, Fenitrothion is currently the insecticide of choice in Sudan, primarily because of good results and familiarity with the product. However, as can be seen in the table above, Fenitrothion is highly toxic to birds and aquatic invertebrates. Testing programs designed into the project will incorporate less toxic inseticides, such as carbaryl and malathion. Fenitrothion should not be used in areas where aquatic invertebrates and birds are likely to be endandered. Provisions for determining these areas have been made by the incorporation of an environmental monitoring specialist as outlined in Appendix A.

6.1.2. Field Testing

As stated in Section 6.1.1. of this E.A., current field testing is in progress. Three tests will be referred to specifically in this section, those being the two Dynamac trials and a trial conducted by Pinto 1988 which was funded by FAO.

The first Dynamac trial, conducted in 1987 and reported in 1988 against Senegalese grasshopper took place in Mali. Results of this trial indicated good efficacy of all eight insecticides against the target. The effects of the insecticides against beneficial and non-target organisms was inconclusive due to high variability within the test data. No impact was observed on birds, mammal or reptiles. Although the residue analysis was incomplete, the data suggested that single application at the dosage applied resulted in rapid decomposition of the insecticides.

The second trial by Dynamac was conducted in 1988 and the results are not available as of this writing. However, the trial, which was designed as an efficacy and environmental impact study, will only produce information on the environmental aspect, due to the lack of sufficient populations of desert locust to conduct an efficacy trial.

Pinto et al. 1988 trial performed on environmental assessment of Fenitrothion use in the Sudan locust and grasshopper control program. The trial was designed to evaluate efficacy toward desert locust, environmental impact and residues. The results of the trial indicated that fenitrothion applied at the recommended dosage was efficaceous in controlling desert locust. Significant effects in both numbers of and species composition of non-target organisms was recorded. Also, some minor phytotoxicity to sorghum was noted.

For the purposes of field testing within the project, for locust control, approximately one ton of the correct formulation of promising ULV insecticides will be obtained and field tested as opportunities occur. The tests are likely to take the form of well monitored applications carried out under operational conditions.

6.1.3. Selection of Pesticides for Sudan Program

The current inventory of usable insecticide for L/G control in the Sudan consists of approximately 70,0001 of Fenitrothion 96 ULV, 100,0001 of Fenitrothion E.C. and 50 tons of Proxpur and Bendiocarb dust. In the recent

past, Fenitrothion has been the product of choice for locust control in Sudan and has given acceptable results. Dusts and baits, containing Proxpur and Bendiocarb have dominated the grasshopper control programs. These compounds will continue to be used. Insecticides such as Malathion and Carbaryl, and the synthetic pyrethroids should be introduced so that experience can be gained in their use and handling. Prescription use of these products around sensitive areas should also be utilized to minimize adverse environmental effects.

The L/G PEA (TAMS, 1988) analyzed the use of insecticide from the chlorinated hydrocarbon group, dieldrin and lindane in particular, and recommended against their use under any circumstances. Due to the high persistence of these chemicals in the environment and the risk associated with their demonstrated accumulation in the adipose tissue of many animals, including human, most of the chlorinated hydrocarbons pesticides have been halted in most industrial countries. In the current L/G campaign in Africa and the Near East, AID has stipulated as a matter of policy that it will not participate in, or otherwise provide assistance to, any locust control program in which chlorinated hydrocarbons such as dieldrin, BHC or lindane are being used, whatever their source.

6.2 Integrated Pest Management (IPM)

Integrated pest management is a term used to refer to the judicious use of the available pest control measures with the objective of achieving the most effective, economically justified, environmentally sound and sociologically acceptable programs of pest population management. By necessity it involves an integrated application of chemical, non-chemical and biological methods; and requires proper understanding of ecological and climatic factors influencing pest occurrence and distribution.

L/G PEA (TAMS/CICP, 1988) cover all the basic background information related to IPM and therefore reference must be made to this document whenever such information is needed.

There are several examples of successful IPM programs for a number of crop pests. However for locusts and grasshoppers no such program has so far been developed and a long time will probably pass before one is made available.

Successful IPM programs depend very much on the availability of basic biological and ecological data on the key pest as well as on the characteristics of the main

components of its ecosystem. At present such information on grasshoppers and locusts in Africa, Asia and the Middle East is lacking and research is needed to avail it. It must be realized that IPM systems are location-specific and so, data generated in one geographic area may not be of much use for constructing an IPM model for another, hence the cost of research for developing IPM programs for locusts and grasshoppers is prohibitive. In addition, even if an effective IPM system is developed in a certain region, there is still a need for extensive and intensive extension work to convince farmers and others of the necessity to continue to adopt certain pest control practices in the absence of grasshopper and locust infestations.

6.3 Application Methods and Equipment

A progressive movement toward ULV application for locust and grasshopper control will be made, as this is the most appropriate formulation for either ground or aerial control. Advances in the technology of baits for grasshopper control will be incorporated into the project as they develop.

6.3.1. Aerial

All aerial application will utilize Micronair (and similar) rotary atomizers. These have proven to give the most appropriate spectrum of droplet size of the available equipment. This droplet size of approximately 100 microns has proven to give good control of the target pest and accurate deposition to the target area. In flight flow regulators and flow meters will be required in all aircraft, allowing the pilot to monitor his application rate on a continuous basis. All applications will be under the direct supervision of a Locust Unit Officer or in the case of an upsurge, a trained second officer. These persons will be required to complete training courses, conducted by FAO staff and on-the-job training. Swath spacing and emission rate will be monitored by the field and base ground crew to ensure that the recommended use dosage is being achieved. To ensure effective control, application will be carried out only when climatic conditions permit accurate deposition of the insecticide on the target area. These being steady winds of between 5 and 10 mph and ground to air temperature relation, which allows for the insecticide to go down.

6.3.2 Ground

A move toward standardization of vehicle mounted ground equipment will be initiated. This equipment will utilize either spinning disc or spinning cages, to ensure correct droplet size and accurate target application. Similar to aerial, all applications will be under direct supervision of the Locust Unit Officer or Second officers. These systems are the safest and most efficient method of ground application, allowing the least exposure possible to the applicator. A small reserve of knapsack sprayers and Microulvas will be retained for EC and ULV application, respectively, in crops.

Daily inspection and maintenance during the program operation will ensure that the equipment is functioning properly and accurately. This will be coordinated by the Spray Machinery Officer, who is identified in the project outline.

6.4 Acute and Long-Term Environmental and Toxicological Hazards

The L/G PEA (TAMS/CICP, 1988) drew a detailed analysis of the acute and long-term risk to both the environment and the public and occupational exposure to the insecticide selected for AID-funded locust control. The primary insecticide that will be used in the Sudan locust control program will initially be Fenitrothion ULV. Fenitrothion ULV is moderately toxic to humans. Other insecticides will be utilized on a limited basis at first and will be expanded as experience is gained in their use. The selection of the chemical to be used in a specific area must take into account the efficacy toward the stage of locust being controlled, the physical condition of the area to be treated and the environmental consequences of the treatment. As each insecticide has advantages and disadvantages in each of these areas, a prescription control method must be instituted.

In the FAO Plan of Operation there is a budget of $10,000 per year for procurement of safety equipment for these individuals.

No long term environmental hazards are anticipated. Careful training of workers, periodical monitoring of operation as detailed in Section 8.0, and rehabilitation of stores and store procedures should reduce as much as possible the chance for spills or mishaps which could cause a concentrated contaminated area. Project operation will take into consideration the situations outlined in Section 5.0 as they relate to long term environmental effects.

6.5 Efficacy of Selected Insecticides for L/G Control

The efficiency of insecticides that could possibly be used in this multi-donor project where USAID is not considered a minor donor, is described in detail in the L/G PEA (TAMS CICP, 1988). This information was compiled from various research trials and control operations conducted in previous years. Much more information is needed and is the subject of the ongoing AID locust control insecticide field testing project. These trials will be similar to that conducted against the senegalese grasshopper by Dynamac in 1987 in Mali, and that attempted by Dynamac in 1988 in Sudan for control of desert locust.

Although research field trials conducted against L/G outside of Africa cannot be directly correlated with what results would be expected in Africa, and specifically Sudan, those results could be used as a starting point for future incountry and incontinent research.

6.6 Effect of Selected Insecticides on Non-Target Organisms and the Natural Environment

The L/G PEA (TAMS CICP, 1988) contains a comprehensive review of the different pesticides used in Africa (both for L/G and other pests), and the possible short and long term environmental consequences of L/G pesticides use. The TAMS/CICP Report should be taken as a guideline for assessment and mitigation of the effects of the chosen L/G insecticides on non-target organisms and the environment in general. Based on that, this Sudanese EA advocates the inclusion of a sound monitoring program component as part of the Core Locust Control Project. The monitoring program would include pre- and post-treatment assessment for each locust control campaign (Sec. 8.0).

The EA of the Morocco Locust Control Project (1988) has drawn the attention to the possible interaction of locust control insecticides with public (vector control) insecticide application programs. This is an area of important concern in Sudan as insecticides are used to combat disease vectors especially those transmitting malaria. Mosquitoes in areas where locust spraying is applied could build up resistance to other chemicals used in their control. However, as most of the areas subject to locust infestation are arid, there should be no concern of increased mosquito resistance except in irrigated schemes such as the Gezira in Central Sudan.

6.7 Conditions Under Which Insecticides are to be Used

A general description of Sudan's natural and human environment was provided in Sec. 5.0. Sudan is a preferred breeding area for the desert locust. Locusts and grasshoppers have plagued all of the Sudan with the exception of the southern region which lies below 10°N. For this reason, the environmental Assessment will exclude the Southern Provinces of Bahr El Ghazal, Al Bohayrat (the Lakes), Upper Nile, Jonglei, Western Equatoria and Eastern Equatoria.

Rainfall averages less than 25mm annually in the northernmost part of the country and generally increases toward the south, averaging 200mm annually around Khartoum, and 800mm on the northern fringes of the swamps. The southern borderlands receive over 1,400mm annually. The rainy season lasts from April to October in the south, decreasing both in length and reliability toward the north.

Natural vegetation in the Sudan may be divided into five main zones - desert, semi-desert, savanna, mountain scrub and swamps. The zones which lie within the L/G region and, therefore, will undergo control treatment, are the desert, semi-desert, part of the savannah and three of the montane areas.

Desert Zone (located north of 17°N and excluding the Red Sea Hills). Annual rainfall is less than 50mm. There is no vegetation here except for what could be found in Bayuda and Atbai deserts. A few ephemeral herbs and grasses grow after the scanty rain.

Semi-Desert Zone (located between 14° - 17°N, including the Red Sea Hills). The vegetation is mainly annual or perennial grasses and herbs with or without woody vegetation. This zone is divided into five sub-zones according to the dominant species or type of soil.

1. Acacia tortilis - Maerua crassifolia Desert Scrub, found mainly in the east.
2. Acacia mellifera - Commiphora Desert Scrub, found mainly in the west.
3. Semi-Desert Grassland on sand (in the west), a vegetation of mixed grasses and herbs alternating with Acacia - Commiphora desert scrub plus a few trees along "Khor" beds and drainage.
4. Semi-Desert Grassland on clay (in the east), a vegetation of mixed grasses and herbs with trees along water courses. The Butana which lies between the Blue Nile and Atbara, is a typical area.
5. Acacia glaucophylla - A. etabaica Desert Scrub, found in the Red Sea Hills.

Woodland Savanna Zone (monsoon rainfall 300-1500mm). Here, because of the presence of tall grass, fire plays an important role in determining the climax vegetation. Most of the plants are fire resistant and the vegetation is of mixed grass and bushes with or without trees depending on the amount of rain. Trees found in the first type are mainly acacias with other species like Commiphora africana, Bosica senegalensis, Balanites aegyptiaca, A. festula, A, senegal, and mixed deciduous woodlands. The High Rainfall Woodland Savanna is a vegetation of mixed deciduous woodland of Anogeissua - Khaya senegalensis and Isoberlinia. Montane Zone In this zone only the Red Sea Hills with Juniperus procers (confined to Korora Hills) and Olea chrysophylla on Jebel Elba; and Jebel Marra with its open grassland and areas dominated by Olea laperrini lie within the Locust Control operation boundaries.

Surface Water Potential evapotranspiration greatly exceeds rainfall throughout Sudan except in the extreme south. Accordingly, nearly all of Sudan suffers an annual water deficit, and the perennial surface water originates outside the country. The Nile and its tributaries are the most prominent surface water feature of the Sudan, and the majority of the country lies within the Nile drainage basin (Fig. 1). The Nile has two main tributaries, the White and Blue Niles. Within the Locust Control Project a number of tributaries are found. The Blue Nile receives two tributaries before it reaches Khartoum. The Dinder which flows mostly from June to December and the Rahad which flows from June through November. The Blue and White Niles meet at Khartoum to form the River Nile which flows northwards for 325km before it meets with its last tributary, Atbara River which flows from June to December only.

A number of seasonal watercourses do not drain into the Nile. Some of the most notable are the Gash, Baraka and some in Darfur. In Jebel Marra region of Darfur a number of seasonally flowing wadis fan out in all directions from the highlands. Other wadis are scattered all over the country. Many agricultural schemes are irrigated from these rivers through intensive canalization systems. Some of the canals are designed to drain excess water from the farm (Hawasha) back to the river. Examples of these schemes include the Gezira, Managil, Rahad, Guneid, Sennar, fed from the Blue Nile, Kennana on the White Nile and Khashm Al-Girba on Atbara River.

Groundwater In general, the Nubian Formation is the best aquifer in Sudan. Recharging in the west is thought to come from Ennedia (in Chad) and Darfur highlands. In the east, infiltration from the Nile is

mainly responsible for recharge. The Um Ruwaba Formation in the southern half of Sudan also contains significant storage. The Gezira Formation is the major aquifer in the Gezira. Other water resources include :

1. Haffirs (natural or excavated)
2. Natural lakes
   a. non-volcanic like Kielak in Kordofan and Kundi in Darfur
   b. volcanic like Marra and Malha in Darfur.
3. Man-made lakes, e.g. L. Nubia in northern Sudan and the lakes behind Sennar and Roseires Dams.

6.8 Availability and Effectiveness of Other Insecticides and/or Non-Chemical Measures

Dieldrin which used to be the main pesticide sprayed for control of desert locust and BHC the main component for baits and dusts against hopper bands and grasshoppers are no longer permitted for such uses because of their adverse environmental impact. Locusts and grasshoppers are now controlled primarily by sprays containing fenitrothion, diazinon, malathion and carbaryl and they are dusted or treated with baits containing either bendiocarb or propoxur and sometimes carbaryl dust.

These pesticides appear to provide satisfactory control of the target species when the correct dosage rate is correctly applied. However, because of their relatively short persistence in hot climates, and their relatively slow action, they may not be ideal for the control of mobile targets such as single bands or swarms.

To enhance the efficiency of these insecticides, the possibility of applying them in mixtures containing synthetic pyrethroids must be considered. Synthetic pyrethroids act relatively quickly, and rapidly immobilize the target after treatment. Although recovery from their action is fast, by the time recovery commences the slower acting component in the mixture will be expected to take over and lead to the end point.

Some such mixtures were tested against the brown locust in Botswana and found to give satisfactory kill. Similar tests must be conducted against the desert locust and the important species of grasshoppers, and careful assessment of the environmental impact of these mixtures should also be performed.

Research to investigate the effect of mixtures containing these insecticides and a growth regulator such as DIMILIN on management of locusts and grasshopper populations must be supported. DIMILIN is expected to interfere with molting of nymphs thus

killing them which avoid to tolerate insecticidal action.

6.9 Ability of GOS to Regulate or Control the Destruction, Storage, Use and Disposal of Selected Insecticides

At the present time and under the current circumstances, the GOS, PPD is not capable of any of the previously mentioned tasks, as they relate to conducting a sound L/G control program or as they relate to the safety of the employees or the general public. In fact, the Medium Term Locust Control Project is a result of this exact situation.

This multi-donor project is an umbrella project for four activities :

1. core locust control
2. pesticide disposal
3. pesticide stores rehabilitation
4. pesticide stores stock procedure improvement.

If the goals of this three year project are met, the GOS, PPD should be in a position to adequately handle the L/G control program as well as ensure the safe destruction, storage and disposal of the insecticide involved in the control of L/G.

In the past, the PPD has been a "dumping ground" for unwanted and unused pesticides from other agricultural sectors within Sudan, i.e. Sudan Gezira Board and Rahad Corporation. These organizations are large agricultural schemes that are primarily involved in the production of food and fiber product for internal country consumption and export. These schemes in fact account for the vast majority of pesticide use in the Sudan. Primarily due to lack of budget within PPD for the purchase of insecticides, they have accepted unused pesticide from the schemes, most of which are either unusable due to physical state or not the correct pesticide for the control programs which PPD is charged with conducting. The World Bank has undertaken a project to improve the pesticide use programs in these schemes, and disposal of old and unusable pesticides. By estimating this influx of unusable pesticide into the PPD system, the control and maintenance of pesticide inventories will be much more manageable.

As outlined in Section 2.3, the GOS has only one law which deals with pesticides, "The Pesticide Act of 1974".

6.10 Provisions for Training Applicators and Users of Selected Insecticides

Training of the staff of the project will be accomplished through utilization of FAO Technical Assistance Staff. This on-the-job training will involve the entire technical staff, from the professionals on through to the technicians. Training will involve all aspects of the control program. The Sudanese professionals within the Locust Unit will be expected to assist in the training of the technicians in the safe use and handling of the insecticides.

Periodic monitoring of safety practices will be carried out, as described in Section 8.0. The group most vulnerable to unsafe use of pesticide and at greatest risk of exposure is the handlers, loaders, applicators and pilots. Particular attention must be paid to this group. Training, supervision and monitoring must be coordinated to ensure that proper procedures for handling the insecticides and proper use of protective equipment is used. Provisions are made within the FAO plan of operations for protective equipment and training. In addition, monitoring of health and safety procedures will be carried out by the Technical Assistance Specialist identified in Section 8.1 and Appendix B.

6.11 Provisions for Monitoring the Use and Effectiveness of the Selected Insecticides

Monitoring of the environmental and health/safety aspects of the program are described in various other sections: 6.9, 6.10, 8.0.

Post treatment evaluations for efficacy are a vital part of any control program. These evaluations must be designed in relationship to the insecticide used, i.e. speed of kill. Evaluations of this type should be carried out under the supervision of the field officer in charge of the program. Proper methods of evaluation for efficacy will be an important component of the Training Program. The field officer short courses, conducted by the FAO technical staff, will include methods for evaluation of treatment programs for efficacy. This evaluation should be designed to be simple and fast, yet accurate, therefore not detracting from the control campaign.

7.0 Environmental Impact of Action

A detailed technical analysis of the full range of potential environmental impacts of locust/grasshopper control programs, which are insecticide based is presented in the L/G PEA (TAMS/CICP, 1988) and will not be repeated here. Sudan does however have specific situations which will be discussed in the following text.

7.1 Adverse Environmental Effects

It is a known consequence of both aerial and ground locust and grasshopper control programs that a significant decrease in non-target organisms will be noted. In particular a decrease in predators, and parasites, pollinators and other insect life. Certain insecticides are known to be more or less toxic to other life forms. For instance, fenitrothion is considered highly toxic to avian life, while the toxicity of carbaryl to this is low. (Sec. 6.1.1.). The more sensitive areas in the Sudan have been described in Section 5.0. Therefore, in these areas careful planning and execution of a needed control program must be carried out. Biological monitoring of the control programs, as outlined in Section 8.0 will alert the project to adverse environmental effects. This information when combined with previous (Dynamac Mali 1988, Sudan 1988) and future environmental studies will allow for continuous fine tuning of locust and grasshopper control programs as they relate to adverse environmental effects.

7.2 Relationship Between Short Term Impacts and Long Term Benefits

The L/G PEA (TAMS CICP, 1988) analyses the risks and benefits, both short and long term, associated with locust control programs. The long term benefits of this Medium Term Locust Control Program will be realized through Sudan's ability to react to whatever the current locust situation may be, ranging from recession to upsurge to plague.

According to analyses conducted for the Project Paper, long term monetary benefits to Sudan alone may range from $4,000,000 to 18,000,000 per year in savings in crop loss. Discounted returns (IRR%) are also

impressive, ranging from 50% to 200% depending on degree of infestation and efficiency of control. If a locust plague is avoided or ameliorated by control efforts, savings could amount to hundreds of millions of dollars over the entire region, to say nothing of the prevention of hunger and misery brought on by food shortage.

The adverse short term impacts, such as effects on non-target organisms and risks of accidents, which will undoubtedly occur in a campaign of this magnitude, will be greatly outweighed by the benefits if there is indeed a serious threat, and if the campaign is waged with a reasonable degree of professionalism.

8.0 Mitigation of Environmental Impacts

There is a vast literature on the prevention and mitigation of environmental impacts of the handling and use of pesticides in general and locust and grasshopper control insecticides in particular. Much of this has been reviewed and analyzed in the context of locust control in Africa and is presented in the L/G PEA (TAMS CICP, 1988). In addition, AID's current L/G insecticide field testing programs is yielding directly relevant information on impacts of specific insecticides and how to minimize them. This section provides guidance on specific environmental and safety mitigative actions which are considered necessary for the Core Locust Control Component of the Sudan Medium Term Locust Control Program in particular.

8.1 Environmental, Health and Safety Monitoring

Based on the observations made and the data collected during the preparation of this EA, several mitigation actions have been identified. In particular these include:

1. Monitoring program for pesticide residue levels in plant tissue, water and soil as a result of a control operation
2. Monitoring of the effects of the control operation on non-target organisms
3. Monitoring of workers, primarily loaders, handlers, applicators and pilots working with the insecticides for safety practices and any change in cholinesterase levels which may result from overexposure to known cholinesterase inhibitors such as Fenitrothion, Malathion and Carbaryl.

8.1.1 Environmental Monitoring (Residue)

Pesticide residue levels in the treatment areas will be monitored on a time scale, similar to that method used by Dynamac in the region testing program. Pre-treatment samples of vegetation, soil and water will be taken to establish a zero level base line. The post-treatment samples will be taken at zero, one, three and seven days after treatment to determine degradation of the pesticide. The information obtained from laboratory analysis of these samples will add to our information base on the persistence of the insecticide used in locust and grasshopper control.

The individual responsible for conducting the monitoring will provide supervision and technical assistance to facilitate the collection of the samples. The individual will be responsible for the design of the sampling program, ensuring its scientific soundness.

8.1.2 Environmental Monitoring (Non-Target Organisms

The effect of the insecticide treatment on non-target organisms, such as predators, parasites, pollinators, birds, fish and other animals will be monitored during the program. The individual supervising the residue monitoring program will also supervise the monitoring of non-target organisms. Comprehensive studies in this type of assessment are time-consuming and expensive. Therefore, this monitoring will concentrate on a few indicator species of insects, plants and animals, which are representative of the parts of the ecosystem which react quickly and manifestedly to insecticide application. In this context, undocumented reports indicate that the White Stork and Bustards have been affected in the past by the use of insecticides for locust control in Eastern Sudan. The non-target monitoring would be the assessment of the changes in population of species selected on the basis of economic and environmental importance. Biological monitoring would also include assessment of changes in species diversity within the treatment area.

8.1.3 Health and Safety Monitoring

Due to the toxic nature of the insecticides used in locust and grasshopper control, it is imperative that monitoring be conducted to ensure the health and well-being of those individuals involved in the control program. As has been outlined in Section 6.10, provision for the basic and on-the-job training of involved personnel will be carried out by FAO technical staff and will be an ongoing process along the chain of command of the PPD Locust Control Unit. Therefore, the individual identified to conduct this monitoring will make periodical observation during a treatment program. The observations will include such things as: safe and proper transport of the insecticides, i.e. loading and unloading, proper storage and safeguard of material at the site of operation, correct usage of safety equipment and clothing and proper transfer of the insecticide from the original container to the application equipment i.e. airplane or ground sprayer. This monitoring could be done in conjunction with the environmental monitoring as outlined in sections 8.1.1 and 8.1.2.

The second portion of this monitoring will be to administer a sound cholinesterase monitoring program. This program will involve procurement of 20 field kits and a supply of associated expendable items for routine monitoring of whole-blood cholinesterase levels in the workers exposed to insecticides in the course of the locust control program. The kits are designed for use under harsh field conditions by technicians with minimal training. The use of these kits will allow the GOS to screen workers for cumulative intoxication with cholinesterase-inhibiting pesticide, including Fenitrothion, Malathion and Carbaryl, thus preventing potential cases of chronic pesticide poisoning.

An individual will be contracted to conduct a training program in the use of the test kit for the Government of Sudan's designated Ministry. The individual will also be responsible for advising the GOS on the development and implementation of a national program for the protection of workers at risk due to high body levels of cholinesterase-inhibiting pesticide based on data collected during the monitoring. The individual would advise the GOS on administrative and management techniques for timely and effective use of worker monitoring results by means of appropriate methods for data management and handling.

8.1.4 Clothing and Personal Protective Equipment

Adequate and appropriate protective clothing and equipment suitable for Sudan conditions will be provided under the FAO/Government of the Republic of Sudan Cooperative Program Plan of Operation. This equipment and clothing is intended for workers in the high risk exposure group, primarily loaders, handlers, ground spray operators and others. These requirements include head and eye protection, organic vapor respirators and chemical resistant coveralls, boots and gloves.

8.1.5 Local Institutional Capabilities

In order to contribute to the sustainability of the project beyond the three years of the multi-donor involvement, it is essential to involve local institutions in the project. It is our understanding that the capability to conduct the necessary environmental health and safety monitoring is available through local institutions. An excellent example of this is the Institute of Environmental Studies, University of Khartoum. Their assistance in the preparation of the project paper and EA was very valuable.

8.2 Insecticide Application in Ecologically Sensitive Areas

A critical responsibility of the individual conducting the monitoring would be coordination with PPD counterparts to identify those areas within the locust control region which are critical habitats for endangered wildlife species, and implementation of an appropriate strategy for minimizing impacts on those species as a result of the locust control project. The guidelines to be followed during spray operations are:-

1. Under no circumstances should aerial application of insecticide occur in protected areas such as national parks, game reserves and sanctuaries (Sec. 5.2). If hopper bands are present in the protected area, treatment should be deferred until the hoppers move out of the area. If compelling circumstances make treatment of hopper bands within the protected area an absolute necessity, treatment should be done

by means of selective spraying of hoppers using ground equipment only. If swarms are present in the protected area, treatment should be deferred until they move out of the area.

2. Other areas which are not legally protected but still are sensitive to insecticide applications should, as much as possible, be accorded the same treatment as the protected areas. Otherwise, minimum guidelines for non-protected sensitive areas are as follows:
   a. During field surveys for locusts, survey personnel should note the presence of any sensitive receptors such as surface water bodies, settlements, cultivated fields, livestock herds, and non-target organisms, including birds, pollinating insects and other wildlife (Sec. 5.0). All such information should be gathered and considered in deciding whether or not to treat, and if treatment is elected, the timing and mode of treatment.
   b. If any endangered species are suspected to be present, treatment should be deferred pending consultation with appropriate officials or specialists.
   c. If the decision is made that a sensitive area is to be treated, consideration should be given to prescription insecticide treatment which will have the lowest possible impact on both terrestrial and aquatic non-target organisms. Special attention should also be given, in the survey process, to allow for the least possible spraying in the sensitive area.

3. Post application biological and insecticide residue monitoring should be performed at selected sites during each locust campaign to identify any adverse environmental impacts of spray operations. Reference is made to Section 8.1.1 and 8.1.2. The results of the monitoring should be factored into planning of subsequent operations in the affected areas.

8.3 Management of Locust and Grasshopper Insecticide Containers

Even in the most sophisticated pest control operation, the empty containers pose a real disposal problem. If these containers are not disposed of properly, they can create severe safety and health hazards and environmental impacts. Disposal of unwanted

and unusable pesticides and contaminated material will be dealt with in the disposal component of the Medium Term Locust Control Program. As this is a phased EA, guidelines and procedures for decontamination and disposal of empty containers will be addressed in that phase of the EA preparation and assessment. .pa

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10.1 Persons Contacted

Government of Sudan

1. Dr. Abdel Moneium Karrar
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APPENDIX A

RECOMMENDED TECHNICAL ASSISTANCE AND COMMODITIES FOR MITIGATION OF ENVIRONMENTAL AND HEALTH/SAFETY IMPACTS

SOW and Costs for Environmental Monitoring Specialist

SOW and costs for Pesticide Safety Specialist

SOW and costs for Cholinesterase Monitoring Test Kit Training Specialist

Specifications and Costs for Cholinesterase Monitoring Test Kits and Accessories

Introduction

The following mitigations have been designed both to incorporate training as a prevention tool and monitoring as a warning tool. It is felt that these actions will help ensure the environmental soundness and human safety of the project. They are designed to be outside the basic core component of the project and report directly to USAID. However, it is intended that these individuals work directly and in cooperation with both PPD and FAO, as these organizations have some similar functions designed within the project. By working as a team, a more effective and efficient training and monitoring program can be established.

The following budgets are on an annual basis. The training aspects will need to take place on a regualr schedule, however, the monitoring will occur only if a control program, either summer or winter or both, is in operation. An additional $2,000. each for years two and three should be budgeted for repalcement of supplies for the Lovibond Test Kits.

Statement of Work and Illustrative Costs
Environmental Monitoring Specialist

1.0 Objective

The objective of the environmental monitoring in the Contractor's Scope of Work is to provide information on environmental impacts of aerial and/or ground application of pesticides used in the Sudan Locust Control campaign. The biological effects of pesticides on the environment can be assessed by monitoring changes in populations of species selected on the basis of economic importance (beneficial insects - locust predators or parasites); known sensitivity to a pesticide, or known vulnerability to a position in the particular ecosystem. Biological monitoring can also be done by assessing changes in species diversity in ecosystems or by studying physiological and behavioral parameters. In fulfilling the above objectives, time and cost could be saved by concentrating on the few indicator species of plants and animals which are representative of the other parts of the ecosystem and which react quickly and manifestedly to the pesticide application.

2.0 Qualifications and Experience

The Contractor shall be a qualified environmentalist experienced in conducting pre- and post-treatment environmental surveys for determination of the environmental impact of insecticide applications for crop and rangeland protection. The Contractor shall have knowledge and experience in standard assessment procedures for biological monitoring associated with pest control efforts, and shall be capable of interpreting data and making programmatic recommendations based on such assessments.

3.0 Statement of Work

A. General

The Contractor's effort shall be organized in such a way as to entail environmental and biological monitoring of the pesticide application program. The Contractor shall be responsible for planning and conducting appropriate pre- and post-pesticide

application environmental monitoring of selected areas, chosen in consultation with Mission and GOS Plant Protection Department. Pre- and post-monitoring of beneficial species, including parasites and predators as well as other species of wildlife, shall be executed. The Contractor's duties shall include interpretation of all data collected during the surveys and development of appropriate programmatic recommendations.

B. Specific

For each locust control campaign during the life of the project in which such services are deemed necessary, the Contractor shall :

1. Assist GOS locust control personnel in delineating protected nature reserves as well as non-protected but nonetheless ecologically sensitive areas within the locust treatment region; identify areas with the potential for harboring endangered species; and advise on appropriate, environmentally sound locust control strategies within these areas.
2. In consultation with Mission and GOS technical personnel, select an appropriate number of candidate test areas of manageable size and reasonably accessible locations, taking into account the ongoing pesticide application program, representative ecological considerations and logistical factors. Monitoring shall be undertaken in areas harboring larval forms undergoing ULV aerial or ground treatment. Test area size shall range from 0.5 to 1ha, and shall be replicated at least once with adequate numbers of untreated control areas. All areas selected for test establishment should be typical of those in which desert locust control is normally undertaken in Sudan.
3. For each test area, perform a detailed baseline pre-treatment count of animals beneficial to the agricultural ecosystems i.e. biological control agents (e.g. BT) or entomophagus (e.g. hymenetra flies) and other locust predators/parasites, pollination and recycling agents (e.g. earthworms). Other taxa including birds, small mammals, wildlife should also be counted (whenever applicable). Techniques to be adopted include sweep netting, pitfall traps, visual transect counts,etc. Perform a similar assessment for each control area.
4. Specify and record the formulation and application rate of the particular pesticide applied to each

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5. Conduct a detailed post-treatment count - for each test plot - of animals beneficial to the agricultural ecosystems, and other taxa as outlined above. Appropriate assessment techniques including carcass counts are to be used. Post-treatment counts should be repeated at suitable time intervals for each test area.
6. Following standard analytical methods, interpret the data collected in order to obtain accurate measures of the adverse effects of each pesticide used on animals beneficial to the agricultural ecosystem.
7. Similarly, quantify direct mortality or other acute effects on the full range of fauna and flora in the test area ecosystems.
8. Participate with the GOS PPD concerning insecticide residue in environmental media. Special attention should be paid to residue monitoring in sensitive areas such as wildlife protected areas and those near surface water features. Attempt to coordinate the residue monitoring program with the post-spray environmental monitoring effort under this scope of work, in order to correlate residue data with observed non-target organism morbidity or mortality.
9. Advise Mission and GOS concerning any recommended actions stemming from the findings of the ecological studies.
10. Summarize all data, findings, conclusions and recommendations resulting from the environmental monitoring analyses in a report to be prepared and finalized within the scheduled level of effort. The report shall include a separate section which fully describes all recommended environmental mitigation actions associated with the Sudan Locust Control Campaign.

4.0 Level of Effort

The estimated level of effort for the contractor for each locust control campaign, inclusive of travel time is 60 days (six day work week).

5.0 Illustrative Costs

ITEM	LS
A. Salary	
1. Consultant 60 days @ 450.	27,000
2. Two technicians 40 days @ 250	20,000
3. Two laborers 40 days @ 50	4,000
Subtotal	51,000
B. Per Diem	
1. Consultant 40 days @ 60	2,400
2. Two technicians 40 days @ 40	3,200
3. Two laborers 40 days @ 20	1,600
Subtotal	7,200
C. Travel	
1. Five return tickets to Port Sudan 5 x 1,000	5,000
2. Five return tickets to El Fasher 5 x 800	4,000
Subtotal	9,000
D. Equipment	5,000
TOTAL	72,200
E. Contingency 10%	7,200
F. Overhead 15%	11,913
TOTAL	91,333

Statement of Work and Illustrated Costs
Pesticide Safety Specialist

1.0 Objective

The objective of this procurement is to contract a specialist to provide training and assistance to the Government of Sudan (GOS), Plant Protection Department (PPD) in the safe handling and use of insecticides used in its locust control program. The program will involve the use of large quantities of insecticide. During a recession, there will only be a limited number of persons exposed to the insecticide who will need adequate training in safety procedures. During an upsurge or plague, when the Unit expands with the recruitment of other PPD personnel, on-the-job training may be required for the new personnel. This training will assist the GOS PPD in safeguarding the health and safety of workers involved in the chemical control of locusts and will enhance the GOS PPD's response capability.

2.0 Qualifications and Experience

The individual shall be trained in a pesticide related field with experience in handling and use of pesticides. The individual shall be knowledgeable in pesticide chemistry and their relative toxicity to humans through various forms of exposure. This individual shall be capable of working with the GOS PPD in all aspects of pesticide handling, from the time it leaves the PPD stores to the time it is applied.

3.0 Statement of Work

A. General

The individual shall have primary responsibility for advising the GOS PPD on pesticide safety within the locust control program. The individual will conduct a training session, in cooperation with PPD and FAO, for the locust unit employees for the safe handling and management of pesticides in the locust control program. The contractor will also provide on-the-job training at the five regional headquarters.

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B. Specific

The individual shall :

1. Prepare a detailed work plan and schedule for Mission review, setting forth the principal tasks under the scope of work, and how they will be implemented, including identification of all Mission, GOS, PPD and FAO support and/or coordination which will be required.
2. Analyst the GOS's official guidelines on pesticide safety for crop protection workers in terms of technical adequacy, compliance monitoring, and internal enforcement procedures within the locust control program and recommend needed changes.
3. Assess the GOS's regulations governing public health protection from exposure to pesticides, especially impacts of crop protection programs employing chemical pest control, and recommend needed changes in regulatory content or provisions for compliance monitoring.
4. Analyse the effectiveness of the PPD's locust control pesticide management system by means of site visits to observe the pesticide handling and use in active locust control areas; recommend improved procedures as necessary. Attention should be given to appropriateness and adequacy of temporary storage facilities located at remote field sites, and training needs of personnel responsible for managing such stores.
5. Analyse the GOS's capability to monitor the publilc health impacts of broadcast pesticide applications to the locust control effort, identify needed improvements, and recommend appropriate actions in response to identified needs.
6. Develop a one or two day in-service training workshop for locust control workers in high pesticide exposure job categories, and stage the workshop at appropriate regional centers in the locust control area. Provide more in-depth training to Locust Unit management personnel, this to coincide with FAO short courses.
7. Analyse the Crop Protection Service's plans and preparedness for emergency response to incidents such as chemical spills, fires and acute pesticide poisoning cases. Identify technical areas or physical locations requiring enhancement and recommend mitigating actions.
8. Summarize all data, observations, findings, conclusions and recommendations resulting from the health and safety analyses in a report. The report shall include a separate section which fully describes all recommended health and safety

mitigation actions associated with the Sudan Locust Contro effort, including implementation procedures, duration, training requirements, estimated capital and recurrent costs, and agencies responsible for execution.

4.0 Level of Effort

The estimated level of effort for the specialist is 30 days.

5.0 Illustrative Costs

ITEM	AMOUNT LS
A. Salary - 30 days @ 450 LS/day	13500
B. Travel - 5 return airfares @ 1,000	5000
C. Per diem - 25 days @ 60 LS/day	1500
D. Contingency 10%	2000
E. Overhead 15%	3300
TOTAL	25300

Statement of Work and Illustrative Costs
Health Specialist

1.0 Objective

The objective of this procurement is to obtain technical services for training fo Government of Sudan (GOS) Plant Protection Department (PPD) technicians in the use of an instrument for the measurement of whole blood cholinesterase levels in workers exposed to pesticides in the course of the locust control program. The instrument to be employed is available in a self contained kit form for use under field conditions by technicians with minimal training. The use of this kit will allow the PPD to screen workers for cumulative intoxication with cholinesterase -inhibiting pesticides (organo-phosphates and carbamates) and thus prevent potential cases of of chronic pestiicde poisoning.

2.0 Qualifications and Experience

The individual shall be a qualified health scientict/technician well versed in pestiicde residue monitoring in biological fluids. The Contractor shall have specific, extensive experience in the use of the "Lovibond" brand calorimetric tintometric whole blood cholinesterase activity measurement kit, or technical equivalent. The individual should have knowledge of the institutional and administrative requirements for implementing a successful and effective pesticide worker screeping program based on the use of the Lovibond test kit.

3.0 Statement of Work

A. General

The individual shall be responsible for conducting a training program in the use of the Lovibond test kit for selected GOS PPD technicians assigned to the current locust control campaign, and shall advise the PPD on the development and implementation of a program for the protection of

workers at risk due to high body burdens of cholinesterase-inhibiting pesticides based on the data collected using the Lovibond kit. The Contractor shall also advise the PPD on administrative and management techniques for timely and effective use of worker monitoring results by means of appropriate methods for data management and handling.

B. Specific

The individual shall:

1. Prepare a brief work plan and schedule for Mission review, setting forth the principal tasks under the scope of work, and how they will be accomplished, including identification of any Mission and SDS support and/or coordination which will be required.
2. Inspect the consignment of test kits and related commodities procured under the Medium Term Locust Control Project in order to verify their condition and suuitability for immediate use in the project.
3. Perform an initial training session in Khartoum for a core group of senior PPD technical personnel, covering use of the kit as well as recommendations for collection, management and use of the data resulting from a national monitoring program. This training session should emphasize fundamentals of the Lovibond kit use in order to enable the PPD core group to assume the training function in subsequent locust control campaigns in Sudan. This training could be in conjunction with FAO short courses.
5. Travel to the five regional headquarters to train field personnel in the use of the Lovibond kit, including methods for interpretation and processing test results. The training should clearly specify criteria for determining which workers should be tested on a regualr basis, and the frequency at which testing should occur.
6. Brief Mission and PPD personnel upon conclusion of the field training program, to identify any constraints to implementation of the monitoring program to make recommendations for prevention of potential problems.
7. Advise PPD management on appropriate approaches for utilising data collected in the pesticide worker monitoring program. Specific guidelines shall be provided on criteria for using test results to identify workers at risk due to excessive pesticide exposure, and management alternatives for effectively removing such persons fromchemical exposure for an adequate amount of time to allow for

8. Prepare a letter report to USAID Project Officer, summarizing relevant findings, conclusions and recommendations, including a proposed procurement plan and schedule for replacement reagents and test kit expendables.

4.0 Level of Effort

The estimated level of effort for the contractor is 27 working days.

5.0 Illustrative Costs

ITEM	AMOUNT
A. Salary - 30 days @ 450LS/day	13,500
B. Travel - 5 round trip air fares @ 1,000 LS	5,000
C. Per diem - 25 days @ 60 LS/day	1,500
D. Contingency 10%	2,000
E. Overhead 15%	3,300
TOTAL	25,300

Statement of Commodity Requirements, Specifications and Costs
Cholinesterase Monitoring Test Kits

1.0 Objective

The objective of this procurement is to provide Sudan's Plant Protection Department (PPD) with an instrument for measurement of whole-blood cholinesterase levels in workers exposed to pesticides in the course of the GOS locust control programs. The instrument to be employed is available in self-contained kit form for use under field conditions by technicians with minimal training. The use of this kit will allow the PPD to screen workers for cumulative intoxication with cholinesterase-inhibiting pesticides (organo-phosphates and carbamates) and thus prevent potential cases of chronic pesticide poisoning.

2.0 Manufacturer

See attached literature

3.0 Supplier

See attached literature

4.0 Specifications

See attached literature.

5.0 Items and Quantities to be Procured, with Illustrative Costs:

ITEM	AMOUNT
Test Kits @ $675	10,125.
Reagents	
Bromothymol blue ampoules 2000 @ $9/500	36
Other Expendables	
Blood lancets - 30,000 @ $25/1000	750
Test Tubes - 150 @ $8	1,200
Test tube brushes - 30 @ $2	60
Stirring rods - 15 @ $3	45
Fused glass cells - 15 @ $18	270
Vol. pippettes (0.01 ml) - 5000 @ $80/1000	400
Shipping and handling (airfreight) 250lbs @ $3.50/lb	875
TOTAL	13,761

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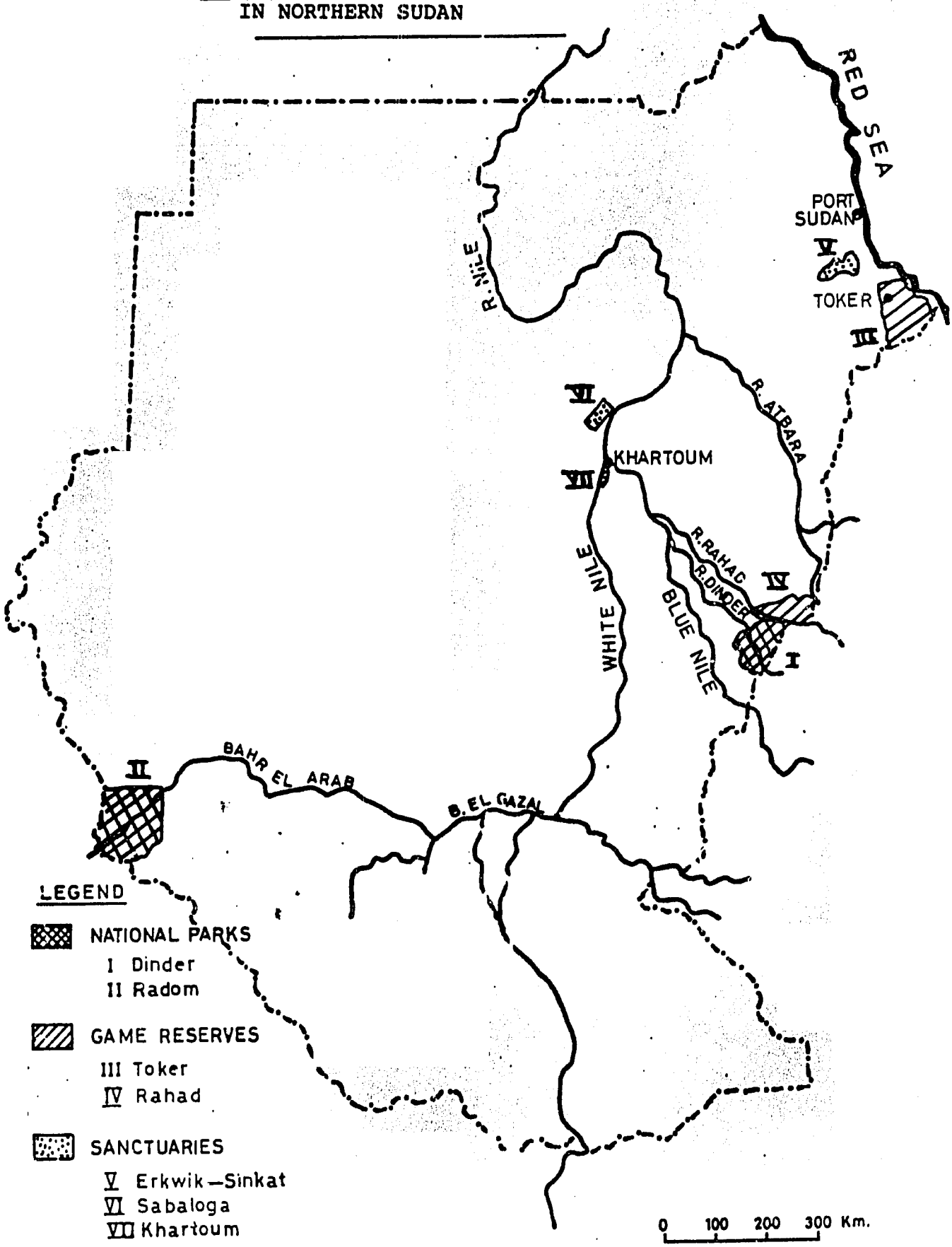
Fig. 1

PROTECTED WILDLIFE HABITATS IN NORTHERN SUDAN



ANNEX I

SCOPE OF WORK AND QUALIFICATIONS FOR SUDAN PROJECT DESIGN TEAM: PHASE II -- PESTICIDE DISPOSAL

I. Team Composition:

- Team Leader - Mission PDO Keeys
- Technical Design Specialist
- Pesticide Sepcialist
- Disposal Engineer
- Environmental Management Specialist/Air
- Environmental Management Specialist/Soil and Water
- Economist
- Social Scientist

II. General:

The technical design specialist will act as the coordinator of the team to develop a pesticide disposal program, and will be under the general supervision of the Mission Project Development Officer (PDO). The team will work with local experts from the Institute of Environmental Studies (IES) and the University of Khartoum whose services shall be provided under a contract by USAID.

III. Technical Design Specialist:

A. General Responsibilities

1. The technical design specialist will work as part of the multi-disciplinary team to develop a project paper (PP) amendment and conduct an environmental assessment for the Sudan Medium Term Locust Control Project which will meet the requirements of 22CFR Part 216 (Environmental Procedures of the Foreign Assistance Act).

2. The technical design specialist will be responsible for the overall coordination of the technical specialists. He/she will work directly with the Mission PDO to ensure that the team's work responds to the Mission's needs for inputs to the preparation of the project paper and environmental assessment.

3. He/she will be responsible for the preparation and submission of the final draft documents to the Mission in Sudan. The draft documents will conform to guidelines contained in Handbook 3 and will contain the following analyses:

- Environmental Analyses
- Technical Analyses
- Economic/Financial Analysis
- Social Soundness Analysis
- Administrative Analyses

4. He/she will be responsible for development of feasibility studies for the various disposal options posed by the team.

B. Specific Responsibilities

1. In coordination with other members of the team and the Mission PDO, define the participation of IES and local experts in the analyses.

2. Work closely with the Mission PDO to coordinate logistics of the technical team and local experts.

3. Work with team members to develop an economic feasibility study of various pesticide disposal options.

4. Provide overall guidance and direction to the team in preparing the draft PP in accordance with Handbook 3 and Mission directives.

5. Develop administrative analysis, in consultation with team members.

6. Provide weekly oral briefings with written material as required to the Mission PDO on the status and progress of the work.

7. Provide final editing and submission of the draft PP in written form, four days before departure from Sudan.

C. Length of Assignment:

The technical design specialist will carry out his/her assignment in Sudan for 8 weeks, arriving on or about Feb. 1, 1989. A six day work week is authorized.

D. Qualifications:

- Preferably a Masters degree in Management, Development Economics or a related field.

- At least 5 years experience in project evaluation and preparation. Must have experience with AID project paper preparation and organization, and experience in assessing the technical and economic feasibility of pesticide disposal.

- Some experience and knowledge of multi-donor project implementation in developing countries.

IV. Pesticide Specialist:

A. General Responsibilities

In cooperation with the other team members, design a safe and efficient method of clean-up and decontamination of PPD pesticide stores and a safe and efficient means of transporting waste materials to the disposal site.

B. Specific Responsibilities:

1. Upon arrival in country compile a complete list of the pesticides and related contaminated materials to be disposed of under the project.

2. Determine location of these pesticides and contaminated materials.

3. In cooperation with environmental management specialists, review types and classes of pesticides and materials to be disposed of and their relative toxicity and hazard.

4. Work with other team members, assess feasibility of handling and transportation of material to disposal site.

5. In cooperation with Environmental Management Specialists, determine needs and methods to ensure safe handling and transport of materials and evaluate the environmental consequences of the handling and transport of materials.

6. Assess the GOS and community practices in pesticides uses and, as appropriate, identify and/or recommend protocols for worker and community safety in the handling, movement and storage of pesticides.

7. In cooperation with team members and IES, develop the criteria and methodology for monitoring environmental impact of clean-up of PPD stores and movement of materials to disposal site.

8. Assist in the drafting of that portion of the Team's report relating to his work.

C. Length of Assignment:

Eight weeks - a six day work week is authorised.

D. Qualifications:

1. An advanced degree in a pesticide related field.

2. A minimum of five years' experience in pesticide safety and handling and environmental impact of pesticides.

V. Disposal Engineer

A. **General Responsibilities:**

1. Design a safe and effective method of disposal of unwanted pesticides and contaminated material.

2. Develop three design scenarious with low, medium and high cost estimates for Mission review and selection to cover (1) disposal of pesticides only, (2) disposal of pesticides plus limited decontamination or disposal of contaminated soil, and (3) disposal of pesticides and the complete clean-up of contaminated sites.

3. Make recommendations for protocols for future handling, storage, and disposal of pesticides which can become part of GOS operating procedures.

B. Specific Responsibilities

1. Review past disposal efforts in the Sudan.

2. Identify possible option as means of disposing of liquid and solid hazardous waste.

3. Evaluate existing facilities in Sudan which could be modified to meet requirements for disposal.

4. In cooperation with team members, review types and classes of pesticides and materials to be disposed of and their relative toxicity and hazard.

5. Review and analyse results and data from OFDA test disposal project.

6. Design appropriate system for disposal of identified liquid and solid hazardous waste.

7. Assist in the drafting of that portion of the Team's report related to his work.

C. **Length of Assignment:**

Eight weeks - a six day work week is authorised.

D. **Qualification:**

1. A degree in engineering with emphasis on disposal of hazardous waste.

2. At least five years' experience in design and operation of hazardous waste disposal facilities.

VI. Environmental Specialist/Air:

A. General Responsibilities:

In cooperation with the other team members, design a safe and effective method of clean-up of PPD stores, transport of materials and disposal of unwanted pesticide and contaminated materials.

B. Specific Responsibilities:

1. Review past disposal efforts which have taken place in Sudan.

2. Review Sudanese laws and regulations dealing with air quality standards.

3. In cooperation with team members, review types and classes of pesticides and materials to be disposed of and their relative toxicity and hazards.

4. Determine and evaluate consequences on air quality of the project activities beginning with PPD stores clean-up and decontamination through to actual disposal.

5. In cooperation with team members and IES develop the criteria and methodology for monitoring air quality in all phases of the project, that being from store clean-up to actual disposal.

6. Review and analyse results and data from OFDA test disposal project.

7. Assist in the drafting of that portion of the team's report related to his work.

C. Length of Assignment:

Eight weeks - a six day work week is authorised.

D. Qualifications:

1. A degree in Environmental Engineering or related field.

2. A minimum of five years' experience in design and operation of air quality monitoring systems.

VII. Environmental Specialist/Soil and Water

A. General Responsibilities:

In cooperation with other team members, design a safe and effective method of clean-up of PPD stores, transport of material and disposal of unwanted pesticides and contaminated materials.

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B. Specific Responsibilities:

1. Review past disposal efforts, which have taken place in Sudan.

2. Review Sudanese laws and regulations dealing with ground and surface water quality and soil contamination.

3. In cooperation with the team members, review types and classes of pesticides and materials to be disposed of and their relative toxicity and hazard.

4. Determine and evaluate consequences of soil and water quality of the project activities beginning with PPD store clean-up and decontamination through to actual disposal.

5. In cooperation with team members and IES, develop the criteria and methodology for monitoring soil and water quality in all phases of the project, that being from store clean-up to actual disposal.

6. Review and analyse results and data from OFDA test disposal project.

7. Assist in the drafting of that portion of the team's report related to his work.

C. Length of Assignment:

Eight weeks - a six day work week is authorised.

D. Qualifications:

1. A degree in environmental engineering or related field.

2. A minimum of five years' experience in design and operation of soil and water quality monitoring systems.

VIII. Economist/Analyst

A. General Responsibilities:

In cooperation with other team members, conduct an analysis of the cost-effectiveness of alternate disposal technologies and assume major responsibility for preparation of the appropriate budget. Assist team leader (USAID) and other team members with any other economic or financial issues which may arise.

B. Specific Responsibilities

1. With disposal engineer and others as appropriate, estimate costs, including loading, hauling, disposal and clean-up costs, for the various disposal methods deemed worthy of consideration.

2. Analyse the various disposal methods under consideration as to cost-effectiveness, time requirements, and general practicability.

3. Prepare overall budget and disbursement schedules for recommended technology.

4. Assume responsibility for writing appropriate section of Project Paper.

5. Assist in the drafting of that portion of the team's report related to his work.

C. Length of Assignment:

Eight weeks - a six day work week is authorised.

D. Qualifications:

1. An advanced degree in Economics, Business Administration or related field.

2. At least five years experience in project design, project evaluation, cost accounting or other appropriate professional activities. Experience with cost estimation on engineering projects is desirable.

IV. Social Scientist

A. General Duties:

Prepare a Social Soundness Analysis addressing:

1. project compatibility with the various sociocultural milieux in which it is introduced;

2. sustainability and spread factors;

3. distribution of costs and benefits among different groups.

B. Special Duties

1. Assessment of the following:

a. size and socio-economic make-up of populations in the immediate vicinity of disposal sites and along transport routes to the disposal site;

b. local perceptions of and reactions to disposal activities;

c. identification of appropriate methods and institutional structures for educating the local populations regarding disposal activities, associated hazards and mitigatory actions;

d. establishment of information sharing system with proper local institutional structures within the context of an overall monitoring effort;

e. develop a system for social monitoring that is socioculturally acceptable within the institutional constraints imposed.

2. In concert with the Pesticide Specialist, Disposal Engineer and Environmental Management Specialists, prepare an Environmental Impact Assessment.

3. Develop a case study impact assessment, either through a non-purposive sampling technique or utilising a grounded theory approach. The survey instrument should be developed by the social scientist.

4. Identify pesticide stores from hence pesticides will be removed and appropriate transportation methods to disposal sites.

5. Identify and assess the institutional arrangements affecting the handling and transportation of the pesticides.

6. Provide to team, as needed, the following information:

a. local technical support capacity
b. other social infrastructural considerations
c. sustainability issues at the institutional level.

C. Length of Assignment - Eight weeks - a six day work week is authorized.

D. Qualifications

1. Ph.D. in an appropriate social discipline, preferably Sociology, or Human Geography, with a strong methodological background.

2. A rural background would be considered a strong asset.

3. A strong interest in, and research experience of, institutional settings and capabilities, most particularly at the local and regional level.

4. Prior experience with environmental/social issues.

BUDGET

PHASE II

	$	LS
1. Salaries		
A. Project Design Specialist 48 days @ $274/day	13,152	
B. Pesticide Specialist 48 days @ $274/day	13,152	
C. Disposal Engineer 48 days @ $274/day	13,152	
D. Environmental Specialist/Air 48 days @ $274/day	13,152	
E. Environmental Specialist Soil/Water 48 days @ $274/day	13,152	
F. Economist 48 days @ LS 450/day		21,600
G. Sociologist 48 days @ LS 450/day		21,600
Sub-Total	65,760	43,200
II. Transportation and Per Diem		
A. Airfare RT $4,500 x 5	22,500	
B. Per Diem		
1. Sudan 5 persons x 56 days x $193	54,040	
2. International 7 persons x $100 x 3 (includes 1 day Rome, if necessary)	2,100	
3. Washington D.C. 5 persons x 2 days x $133	1,330	
Sub-Total	79,970	
III. Logistical Support	5,464	
- Vehicle Hire and Taxis		80,000
- Secretarial Services		15,000
- Photocopying		5,000
- Miscellaneous Expenses		10,000
IV. Overhead (100% of Salaries)	75,360	
TOTAL	226,554	153,200

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Local Payment Procedures:

a. Dames and Moore/Louis Berger International, Inc. (DM/LBII) shall receive occasional cash disbursements up to LS 2,000 daily and/or check advance in Sudanese pounds up to 100% of estimated costs after arrival in Khartoum and submission of a grant request by DM/LBII's authorized representative to USAID/Sudan Controller.

b. DM/LBII shall make direct disbursements to local contractors in Khartoum upon the local suppliers' delivery of services.

c. DM/LBII shall submit vouchers for local currency disbursements to the Controller, USAID/Sudan and submit all remaining cash balances to liquidate all advances prior to departure from Khartoum.

ANNEX J

PROJECT TECHNICAL ASSISTANCE

TERMS OF REFERENCE AND PERIODS OF APPOINTMENT OF PROJECT EXPERTS MEDIUM TERM LOCUST CONTROL PROJECT

(Derived from the FAO June, 1988 Plan of Operation)

Note "He" should be taken to cover male and female.

1. Chief Technical Advisor - 36 person months

He will advise the Head of the Locust Section on all aspects of the operation of the Project. He will inform the Steering Committee of project progress. He will, in collaboration with the National Coordinator, render a written report to FAO Rome every 6 months and at the end of the project render a Final Report also in collaboration with the NAtional Coordinator. He will be responsible for supervising the work of the other Project experts. He will be responsible for disbursements under the Project within his authority and carry out such disbursements and ordering in the prescribed manner. He will be responsible for the administration of the FAO section of the Project. Over and above this, he will organize and participate in all training courses. In addition, he will assist in the preparation and implementation of associated Projects concerned with the rehabilitation of pesticide stores, the disposal of outdated pesticide and the improvement of stores procedures.

He will take the main burden for the production of the Locust "Manual" and organize and edit the inputs of other experts. He will take an active part in developing improved locust survey methods mainly by on-the-job training in the field, and in the development of the Information Service.

Requiremsnts

Substantial experience in plant protection in the developing world, at a responsible level including direction of staff. Knowledge of locust survey and control, and knowledge of Arabic would be advantages.

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2. National Coordinator - 36 person months

Under the direct supervision of the Chief Technical Adviser and in close cooperation with the Head of the Locust Section, the NAtional Coordinator, who will be recruited locally, will assist in all technical and administrative activities relevant to the effective implementation of the project. For this, he will in particular maintain close liaison with staff in the Ministry of Agriculture and the Plant Protection Department, with members of the Steering Committee and with the FAO office in Sudan. He will also ensure liaison with the other program components and identify any shortcomings in the harmonious implementation of the overall program and propose possible solutions. He will participate in field missions and prepare and implement training activities. He will prepare the necessary reports on activities undertaken.

3. Grasshopper Expert - 24 person months

He will develop and introduce on a trial basis in one region a system of overall assessment of grasshopper incidence and distribution, in collaboration with regional PPD staff. He will determine "threshold levels" of insect density justifying control for various insect stages and stages of crop development for the major food grains. He will develop and test methods of control suitable for use by farmers or unskilled laborers. He will in close collaboration with PPD officers introduce during the third year of the Project a system of control in one Region based on the "threshold level" concept with if feasible some payment system by farmers for the services they receive. He will plan a training course for the PPD officers involved, and produce instruction materials and publicity leaflets to explain the exercise.

Requirements

Experience and knowledge of crop loss assessment in the developing world. Some knowledge of standard control methods essential; direct grasshopper research experience would be an advantage.

4. Application and Control Expert - 36 person months

The German Agency for Technical Cooperation has made available to DLCOEA in Sudan an expert on pesticide application. This expert will provide inputs to the Project. He will field test pesticides for locust and grasshopper control. He will also field test ULV ground spray equipment and attempt to arrive at a standard recommended vehicle mounted machine. He will train Locust Section staff in control methods, especially methods of ULV ground control and of aerial control. He will assist the person in charge of operations in the field in the event of a major campaign. He will assist the Chief Technical Adviser in producing the "Manual" in his stead when the Adviser is on leave.

5. Management and Logistics Expert - 21 person months

The post will be filled through local hire. The expert will assist the Chief Technical Adviser in all logistics aspects of Project management and implementation, including the establishment of the regional bases. The expert will also provide the necessary assistance to the other program components. A short term consultant should be recruited to assist the PPD to set up a management and logistics system (3 m/m).

Requirements

Experience of Project administration and management; experience within Sudan would be an advantage.

6. Survey and Field Operations Expert - 11 person months

He will be assigned to a different Locust Section field base in each visit. The officer in charge of the base will act as his counterpart. The expert will, by on-the-job training, develop the skills of field base staff in all aspects of their duties including survey, base organization, ground and aerial control methods, safety procedures. He will assist with training courses.

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Requirements

Thorough knowledge and substantial experience of locust survey and control. Experience in operating a locust base would be an advantage.

7. Information and Forecasting Expert

A UB Associate Professional Officer currently on the FAO staff will be available to work in Sudan from April 1988 onwards. This will not be a charge on the project. During his mission he will assist the Locust Section in the Improvement of the Information and Forecasting Service in particular the functioning of regular radio contact between Khartoum and the field, in the use of weather information, in the presentation of the locust situation to the head of the Locust Section and the Senior Technical Adviser. He will assist with training courses which occur during his time in Sudan.

8. Spraying Equipment and Calibration Expert

A short term consultant (4 p/m) will be recruited to advise on spraying equipment and calibration and to develop guidelines.

9. Monitoring and Evaluation - 4 person months

Short term consultants will be hired for Project monitoring and evaluation (4 m/m).

MEDIUM TERM LOCUST CONTROL PROJECT

FAO Management Plan

The Medium Term Locust Control Project will be managed by the Chief Technical Adviser (CTA), leader of FAO's technical assistance team. The Chief Technical Adviser will communicate directly and submit regular reports to Desert Locust Control Operations (DLCO) FAO/Rome, which will provide guidance to the CTA on programmatic, technical and management issues. The CTA also will keep the local FAO office informed of all activities.

FAO/Rome has primary responsibility for the project. The local office in Khartoum will provide basically administrative support, such as payroll administration, telex and other communications services. FAO/Khartoum occasionally will provide advice on programmatic issues, as requested.

The CTA is responsible for developing yearly workplans, the training needs assessment and plan, and for managing the project budget. The CTA is responsible for developing the project procurement plan, including the submission of field procurement purchase orders to FAO/Rome Procurement Unit for processing.

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