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SUPPLEMENTARY ENVIRONMENTAL ASSESSMENT

FOR LOCUST/GRASSHOPPER CONTROL

IN KENYA

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
(USAID)

IN COLLABORATION WITH

THE GOVERNMENT OF KENYA

Nairobi, Kenya
November 1993

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PREFACE

This document is a supplement to the Programmatic Environmental Assessment (PEA) for Locust and Grasshopper Control in Africa and Asia (TAMS, 1989). This Supplementary Environmental Assessment (SEA) was prepared by USAID/Kenya and a specialist provided by USAID/W through the Africa Emergency Locust/Grasshopper Assistance (AELGA) Project which is currently resident in AFR/AA/DRCO, along with support from the Government of Kenya (GOK) and the Desert Locust Control Organization - East Africa (DLCO-EA). Document preparers and contact persons are listed in Appendix A.

The document has been reviewed by USAID/Kenya, USAID/W, and the Government of Kenya. It reflects the best current description of future options for USAID assistance to the Kenya Crop Protection Branch for locust/grasshopper (l/g) management. The document also presents the best available estimates of human health and environmental risks, along with possible mitigating strategies. Mitigation may include training programs covering improved health and environmental protection, as well as support for early survey and spot treatment programs. Encouragement is given for use of alternatives to chemical pesticides, along with prudent and environmentally sound use of pesticides when these materials are necessary. Commitments for any possible future program are contingent on future needs for l/g control, the capabilities of the Kenya Crop Protection Branch of the Ministry of Agriculture (CPB/MOA), and on a decision by USAID to provide assistance.

While the document primarily concerns l/g management of populations entering from the northern regions of Kenya, it may also serve to guide control efforts for other pests in other parts of the country, given the gathering of appropriate additional information.

ACRONYMS AND ABBREVIATIONS

AChE	AcetylCholinesterase
AELGA	African Emergency Locust/Grasshopper Assistance Project - USAID/Washington
USAID/W	U.S. Agency for International Development, Washington, D.C.
CPB	Crop Protection Branch, MOA
CFR	U.S. Code of Federal Regulations
COBRA	Conservation of Biodiverse Resource Areas Project
DLCO-EA	Desert Locust Control Organization - East Africa
DOD	Department of Defense, GOK
DRCO	Disaster Response Coordinating Office, Africa Bureau, USAID/W
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
FAO	United Nations Food and Agriculture Organization
GIFAP	Groupement International des Associations nationales des Fabricants de Produits Agrochimiques
GCK	Government of Kenya
ha	hectare
ICIPE	International Center for Insect Physiology and Ecology
IGR	Insect growth regulator
IPM	Integrated Pest Management
KARI	Kenya Agricultural Research Institute
KWS	Kenya Wildlife Service
km	kilometer
l/g	locusts/grasshoppers
MOA	Ministry of Agriculture, GOK
ODA	United Kingdom Overseas Development Association
PAWS	Protected Areas and Wildlife Service Project (World Bank)
PCB	Pesticide Control Board, GOK
PEA	Programmatic Environmental Assessment
REDSO	Regional Economic Development Support Office
SEA	Supplemental Environmental Assessment
TAMS	TAMS Consultants, Inc., New York, NY/Arlington, VA, USA
USAID/ Kenya	USAID Mission to Kenya, located in Nairobi
USDA	US Department of Agriculture

1.0 EXECUTIVE SUMMARY

This assessment is a supplement to the Programmatic Environmental Assessment (PEA) for Locust and Grasshopper Control in Africa and Asia (TAMS, 1989). It was developed to provide particular, country-specific details in Kenya in order to allow USAID assistance in Locust and Grasshopper Management. It is therefore an extension of the PEA for Locust and Grasshopper Control and is, as such, an integral part of it.

The information contained in this document is intended for use by USAID/Kenya and the Kenya CPB to guide environmentally sound locust and grasshopper management for all regions of the country. Among the acridian species which threaten agriculture in Kenya, the Desert Locust, (Schistocerca gregaria) is the most serious, and much of the discussion in this SEA will be directed towards that species. However, the discussions herein need not be limited to a specific pest or region of the country, provided that consideration is given to the considerable climatic, biological, and environmental diversity of Kenya. Additional relevant information could be added to this SEA as needed, as this is a dynamic, rather than static document. As it is part of the PEA, both documents should be consulted during all planning and operational stages of implementation.

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

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

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

The Kenya CPB and its associated parastatal, the Kenya Agricultural Research Institute (KARI), should implement a laboratory analysis program to monitor pesticide formulation

quality, environmental residues, and effects on non-target species and the environment. Whenever possible and necessary, analysis of blood cholinesterase testing in pesticide handlers and applicators is strongly recommended.

Environmental awareness is emphasized. Fragile ecological areas need to be protected from pesticides, as the impact can be both dramatic and long-lasting. Buffer zones of at least 5.0 kilometers surrounding ecologically sensitive areas should be supported in any U.S.-funded control operation. Because of the Kenya's great environmental diversity and the importance of wildlife to Kenya's ecology and economy, this document recommends that U.S.-funded assistance in l/g management promote alternatives to the use of chemical pesticides. Several strategies exist which can allow for substantial l/g control; this SEA recommends that FAO take a lead in this area, because of that organization's considerable experience with such efforts in Africa and Asia.

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

2.0 PURPOSE AND PROCEDURES

2.1 Background

With the major upsurge of the Desert Locust (Schistocerca gregaria) in Africa beginning in late 1986 and lasting into 1989, and extensive grasshopper (numerous species) outbreaks throughout the Sahel from 1986 through 1989, the U.S. government was called upon by concerned African nations to assist with technical expertise and needed materials in the management of these insects. In 1987, the Administrator of the U.S. Agency for International Development declared an emergency waiver of the agency's environmental procedures governing the provision of pesticides. The waiver permitted USAID to provide assistance for procurement and use of pesticides for l/g control without full compliance with the Agency's environmental procedures. The Administrator's waiver expired on August 15, 1989.

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

Given the periodic nature of locust outbreaks, and the cyclic population fluctuations of grasshoppers, control campaigns for these insects are likely to continue indefinitely. Locusts and grasshoppers are part of the ecology of the African continent, and will readily take advantage of agricultural crops. Control measures must manage problematic insects at economically reasonable levels in regard to crop loss, rather than try to achieve extermination. A goal of any U.S.-funded assistance in l/g management should be sustainability of operations by the Kenya Crop Protection Division.

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

to provide assistance to Kenya. Because control operations against the Desert Locust would most likely be concentrated in the northern parts of the country, this SEA emphasizes, but does not restrict itself to, those parts of Kenya.

2.2 Drafting Procedures

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

This draft Supplementary Environmental Assessment (SEA) for the country of Kenya was produced in October, 1993, by USAID/W (AFR/AA/DRCO) contractor David Evans with assistance from Steffi Meyer, Carolyn Mutamba, Michele McNabb and personnel of the USAID/Kenya Projects Office (PRJ). The USAID/Kenya Agriculture Office (AGR), the Population and Health Office (PH) and the Regional Economic Development Support Office (REDSO) assisted in preparation of the draft by providing reference documentation and contacts within the Kenya government and associated parastatals, FAO, and DLCO-EA.

2.3 Previous Assessments

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

Other assessments regarding locusts or grasshoppers include:

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

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

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

(4) **Draft Environmental Assessment of the Tunisia Locust Control Campaign.** (Potter et al, 1988);

(5) **Supplementary Environmental Assessments** for the countries of Burkina Faso, Cameroon, Chad, Eritrea, Ethiopia, Madagascar, Mali, Mauritania, Mozambique, Niger, Senegal, and Sudan.

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

In addition to the above locust-specific documents, there are other documents which concentrate on pest management issues or environmental and biological aspects of Kenya. Of particular interest is Schaefers: **A Review of Pesticide and Environmental Management Capabilities in East Africa.** Current agricultural production information is found in Republic of Kenya: **Economic Survey. 1993.** Ominde: **Kenya's Population Growth and Development to the Year 2000 AD** treats a number of environmental issues in terms of increasing population pressure. Kenya Wildlife Service: **Policy Framework and Development Programme, 1991-96** provides information on protected areas and the organizations strategies for wildlife and environmental protection. These documents are fully cited in the Reference section 5.0, and should be consulted for further information.

2.4 Environmental Procedures.

It is USAID policy to ensure that any negative environmental consequences of an USAID-financed activity can be identified and mitigated to the fullest extent possible prior to a final funding and implementation decision. This document covers specific environmental consequences involved with chemical pesticide use, and necessary safeguards and mitigation for any future control programs. In addition, alternatives to chemical pesticide use are highly recommended when appropriate, and considered to be part of an overall integrated locust/grasshopper management (IPM) program.

Although Kenya does not have procedures precisely equivalent to the National Environmental Policy Act (NEPA) or USAID Environmental Procedures, it does have sets of regulations governing the substance of such programs. These are covered in the following section. USAID Environmental Regulations and Procedures are likely to be controlling for the present because they are more comprehensive and more applicable to USAID programs and projects.

2.5 Kenya Environmental Procedures.

2.5.1 Kenya Pesticide Regulations.

To facilitate proper and safe use of pesticides, regulations are necessary which cover importation of pesticides, distribution to agricultural areas, actual use of the pesticide, and disposal of unwanted pesticide and used containers. Kenya enacted the Pest Control Products Act (Chapt. 345) in 1982, and it became operational in 1984. The Act represents one of the more advanced pieces of pesticide legislation in East Africa. Registration of all products imported into Kenya is required, and standards are specified for packaging, labeling, and data necessary for registration (Schaefers, 1992b).

The Pest Control Products Act also established the Pest Control Board (PCB) which functions in the areas of regulations, and technical and training information. Regulatory functions control sale and distribution of pest control products through licensing of imports and exports. Technical functions are:

- to assess and evaluate data on merits of pest control products in order to evolve recommendations for use;
- to undertake investigations into the impact of pesticides on the environment through collaboration with other institutions;
- and to collect information from international organizations regarding the use of pest control products.

Constraints include some reluctance in cooperation from agrochemical companies, although this is improving, and a shortage of personnel resources for carrying out the inspection function. In spite of import regulations, smuggling remains a concern. Many functions are covered, or will be covered, in a series of subsidiary regulations concerning licensing of premises, registration regulations, import and export regulations, labeling, advertising, and packaging. Information for this subsidiary legislation is compiled by technical sub-committees, but it is apparent that these committees need reinforcement expertise. This SEA supports the placing by GOK of high priority on effective enforcement of this potentially very effective pesticide legislation.

While Kenya has adequate regulations on pesticide use, the PCB and the Crop Protection Branch of the Ministry of Agriculture also consults international regulations in making decisions. Other sources of information are the European Economic Community (EEC), Food and Agriculture Organization (FAO), The World Bank, and other countries such as the U.S. and the U.K.

A U.S. pesticide contribution to Kenya, or a U.S.-funded pesticide purchase in Kenya, will be controlled not only by

applicable Kenyan laws and regulations, but also by U.S. pesticide regulations and procedures, as described in the PEA. In this regard, only those pesticides listed in the PEA, or amendments thereof, are acceptable unless this SEA is amended to cover possible environmental impact which may result from use of that particular pesticide. Pesticides used in a U.S. operation are to be used according to label instructions only. Used pesticide containers and any unwanted pesticide resulting from a U.S.-funded operation must be disposed of properly and safely. No U.S. funds shall be used to purchase, transport, or apply any pesticide that has been banned in the United States. This especially includes chlorinated hydrocarbons such as dieldrin and lindane.

2.5.2 Other Environmental Regulations in Kenya.

Responsibility for environmental protection is divided among several different Ministries in Kenya. The Ministry of Agriculture is responsible for crop protection and production, as well as designating land use for agriculture. The Ministry of Livestock Development specifies areas available as grazing land, while the Ministry of Environment and Natural Resources supervises forest management and conservation. Water management is overseen by the Ministry of Water Development, and soil conservation is incorporated into responsibilities of the Office of the President. The Ministry of Wildlife and Tourism is the parent organization of the Kenya Wildlife Service, and is concerned with hotel developments in ecologically sensitive areas.

The organization responsible for managing Kenya's park and reserve system is the Kenya Wildlife Service (KWS), a parastatal created by the GOK in 1990. A major goal of KWS is conservation of the natural environments of Kenya and their flora and fauna. KWS is closely involved with other GOK organizations (National Environmental Secretariat, Forestry Department) and ministries (Agriculture, Energy, Fisheries, Tourism, Water, and Arid and Semi-Arid Lands) which have environmental mandates. KWS and the Forestry Department recently concluded a Memorandum of Understanding for a cooperative program to manage some of the forests which surround several National Parks and Reserves, but were outside KWS's management.

Parks and reserves are protected under the Wildlife Conservation and Management Act (1976). The act also covers marine parks and reserves, but no specific regulations have been promulgated.

Any USAID/Kenya-funded programs involving pesticide use for locust or grasshopper control should follow Kenyan regulations concerning the protection of designated areas. In that regard, this SEA supports the GOK commitment to protect the natural

environment, and adopts any GOK-mandated conditions limiting the use of pesticides, and also concurs in any designated zones that are protected from pesticide use.

3.0 PROJECT DESCRIPTION

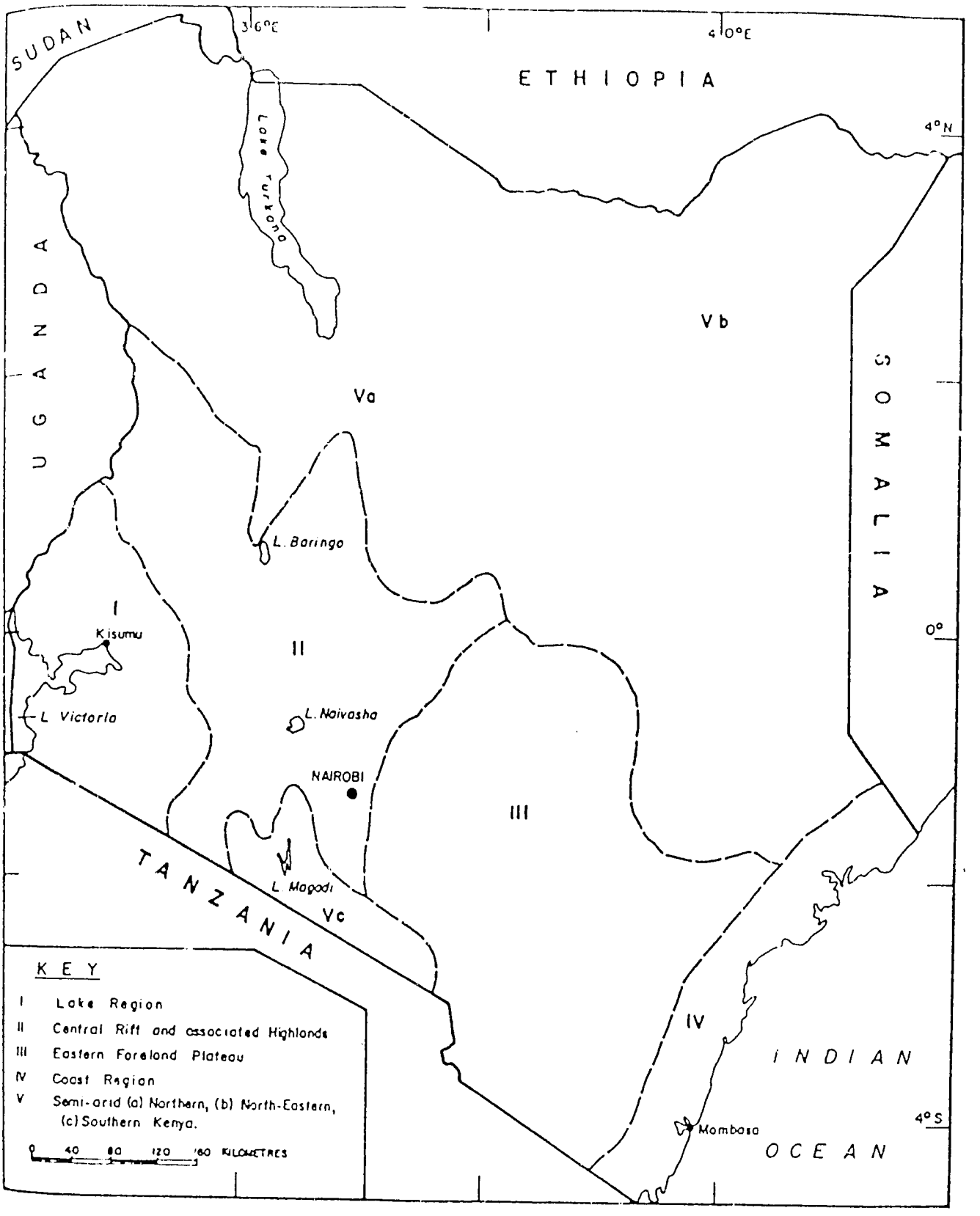
3.1 Kenya Environmental Profile

Kenya lies on the equator and has a land area of 57 million ha. It is bounded by the Indian Ocean and Somalia on the East, Ethiopia to the North, Sudan to the Northwest, Uganda to the West, and Tanzania to the South. Kenya contains some of the world's most diverse and spectacular large mammal and bird communities, and a spectrum of natural habitats ranging from mangroves and coastal estuaries through semi-arid plains to highland forests and alpine tundra. The country is divided geographically into seven regions (Fig. 1). The coastal plain (IV) has adequate rainfall for maize, cassava, bananas, and other crops; the Tana and Northern plains (Vb) have low rainfall and are suitable for nomadic herding. The Eastern Plateau (III) includes the southern plains which consist primarily of bush and scrub to the wooded uplands of the Taita Hills and Chyulu Range. The diverse and agriculturally productive highlands of Mt. Kenya and two ranges of highlands east and west of the Great Rift Valley (II) include both staple as well as cash crop production. The northern (Va) and southern (Vc) areas of the Rift Valley are semi-desert and support nomadic pastoralists, while the more elevated central section is suitable for grain crops and for grazing areas.

The climate in Kenya ranges from tropical humid on the Indian Ocean Coast through the dry heat of the coastal hinterland, to the temperate plateau and cool mountain areas. Seasonal variations are distinguished by duration of rainfall

Figure 1.

MAJOR GEOGRAPHICAL DIVISIONS OF KENYA



rather than temperature. Only 15% of the total area receives more than 77 cm. of rain per annum and only 12% between 50 and 77 cm. The remaining area receives less than 50 cm., which is insufficient for most crops. Most regions have two rainy seasons, "long rains" from April to June, and "short rains" from October to December. The area under arable and permanent crops was estimated at 12.3 million ha. in 1980, permanent pasture at 3.8 million ha., and forest and woodland at 1.9 million ha.

The country has one of the highest population growth rates in the world, 3.5-4.0%, and the pressures on productive farmlands are steadily increasing. Among the countries in East Africa, Kenya perhaps more than any other is facing a rapid increase in the use of pesticides. As the country becomes more dependent on increased production in order to support its exploding population, there will likely be an increasing dependency on pesticides in order to optimize yields.

3.2 Agricultural Resources

The Kenyan economy is highly dependent on agriculture. The majority of Kenyans make their livelihood in agriculture and the agricultural sector offers employment to the majority of the population: it provides food to the country and produces surpluses for export and local industry. Kenya's exports are dominated by agricultural products. Agriculture employs 78% of the labor force and contributes 86% of the GDP. It accounts for the bulk of total export earnings with principal crops in order of marketed production being tea, coffee, maize, wheat, sugar, sisal, and pyrethrum. Tea earnings have only recently surpassed those for coffee (Table 1).

Drought, political disturbance, ethnic clashes, and declining world market prices for critical commodities, e.g. coffee, have resulted in poor performance in the agricultural sector over the past several years. As agriculture is the most important component of Kenya's economy, the effects of the decline have been felt nationwide, and Kenya has been placed in the position of needing to import progressively more agricultural products in recent years. Table 2 shows increasing wheat imports and decreasing production in the years since 1988. Kenya also has a history of self-sufficiency in maize production; however, 500,000 metric tons had to be imported in 1992. This was the first maize imported since 1984, and it appears that additional maize will need to be imported in 1993 and beyond. The agricultural economy at this point is one which is highly vulnerable to additional stresses, such as insect pest outbreaks or invasion by locusts.

Table 1. Principal Exports, 1988-92 (GOK, Economic Survey, 1993)

Commodity	unit	1988	1989	1990	1991	1992*
Coffee	Tonnes	90 831	98.041	114 384	84.191	78 147
Tea	..	138.201	163 279	166 405	175.557	166.518
Petroleum Products	Mn Lt	828	646	638	767	769
Pyrethrum Products	Tonnes	488	540	453	442	241
Meat products	..	71	401	1.585	2.153	401
Sisal	..	30.937	32.856	30.125	27.743	32.026
Hides and Skins	..	17.580	10.153	1.093	274	410
Soda Ash	.	228.384	206.812	185.179	197.427	163.521
Fluorspar	.	98.105	81.204	88.229	55.679	66.538
Cement	..	346.640	313.884	329.539	304.917	392.144
Maize(raw)	..	167.237	110.241	159.883	18.720	417
Horticulture **	..	161.754	134.178	168.825	169.292	154.112
Butter and ghee	..	225	262	418	49	75
? Cotton(raw)	..					
Wool	..	795	445	..	2	983
Animal feeds	..	7.532	11.238	7.938	34.692	14.219

* Provisional.

** Horticulture includes cut flowers, fruits and vegetables, both fresh and processed.

Table 2. Production and Imports of Wheat 1988-92 (GOK, Economic Survey, 1993)

'000 Tonnes

YEAR	PRODUCTION*	IMPORTS	TOTAL
1988	234.0	75.6	309.6
1989	244.2	123.5	367.7
1990	190.1	322.6	512.7
1991	195.0	450.0	645.0
1992**	125.9	382.6	508.5

* Includes rentention for seed.

** Provisional.

Kenya's tropical climate, modified by topography and adequacy of rainfall, permits cultivation of a variety of crops ranging from tropical to temperate. Important temperate crops include maize, wheat, millet, sorghum, rice, other food grains, beans, potatoes, oilseeds, cotton, and tobacco (Table 3). Subtropical and tropical crops mainly consumed domestically are sugarcane, cassava, and bananas; as well as export commodities including coffee, tea, pineapples, sisal, pyrethrum, wattle, and cashew nuts. Maize is the principal staple crop and is grown widely on both subsistence and large market-oriented farms. Wheat has become the most important cereal crop after maize. Beans are also an important staple.

Of Kenya's 44.6 million ha. of land, only 8.6 million ha., or 19%, are medium to high potential agricultural land. Much of the rest is used for extensive livestock grazing or taken up by national parks or forest reserves. The limited supply of arable land combined with the high population growth rate has generated severe land pressure. The land of highest potential lies in the southwest corner of the country, with a strip of dry but utilizable land extending up the Uganda border in the west. There is a productive strip along the coast. The remainder of the country is arid, becoming desert in the northwest. Maize is grown throughout the country, but the most important surplus production areas are in the western sub-humid zones. Wheat is predominantly grown in Rift Valley Province, while sorghum and millet are important crops in the drier areas around Lake Victoria and in Eastern Province. Sugarcane is grown primarily in the Lake Basin area. Coffee and tea are produced in sub-humid and humid areas respectively, both east and west of the Great Rift Valley (Fig. 2).

Livestock are of particular importance in the farming economy of Kenya, and 73% of the total land area can only be exploited by some form of livestock husbandry or by tourism. Livestock products comprise over one-third of the total foods available in the country. Cattle are by far the most important grazing species, with cattle, sheep, goats, and poultry managed in all districts (Table 4).

3.3 Locusts and Grasshoppers

The insects considered in this document are locusts and grasshoppers. The locust pest species of greatest importance in Kenya is the Desert Locust (Schistocerca gregaria). Swarms of the African Migratory Locust (Locusta migratoria) and the Red Locust (Nomadacris septemfasciata) have also caused serious damage in the country. In addition, there are a number of

Table 3. Estimated Production of Selected Agricultural Commodities, 1988/89 - 1992/93 (GOK, Economic Survey, 1993)

(Based on Crop Forecast Surveys)

million bags

CROP	1988/89	1989/90	1990/91	1991/92	1992/93*
Maize	30.68	29.23	25.44	22.05	23.40
Beans	2.70	2.85	2.34	2.10	2.39
Potatoes	2.55	2.59	2.13	1.95	2.26
Sorghum	1.18	0.99	0.88	0.82	0.85
Millet	0.49	0.57	0.40	0.35	0.45

* Provisional.

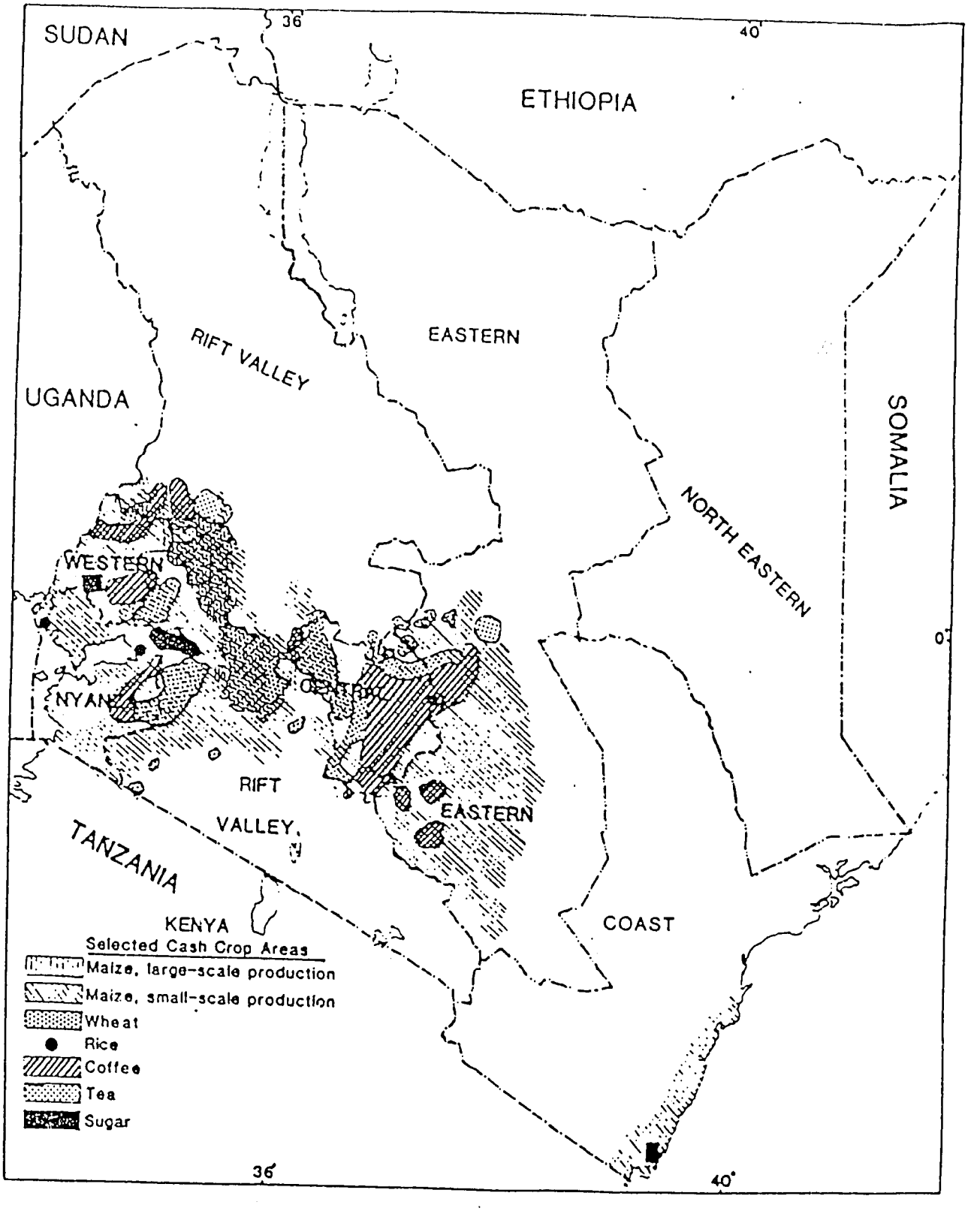
Table 4. Production and Sale of Livestock and Dairy Products, 1988 - 92 (GOK, Economic Survey, 1993)

	UNIT	1988	1989	1990	1991	1992*
KENYA CO-OPERATIVE CREAMERIES						
Recorded Milk Production**	Mn. Litres	359	353	392	359	220
Milk Processed:						
Wholemilk and cream	Mn. Litres	346	373	340	321	207
Butter and ghee	Tonnes	4,187	4,195	4,550	3,479	3143
Cheese	"	247	215	172	250	172
Dried wholemilk powder	"	1,717	1,030	1,396	975	468
Dried skim-milk powder..	"	2,387	3,200	2,992	3,035	2917
Other products	"	451	610	399	387	1056
Livestock slaughtered	"					
Cattle and Calves..	'000 Head	701	752	828	969	921
Sheep and Goats	"	942	996	1,206	1,345	1278
Pigs	"	63	73	84	83	81
KENYA MEAT COMMISSION						
Intake of:						
Cattle and Calves..	'000 Head	10	27	68	59	25
Sheep and Goats ..	"	-	-	10	6	-

* Provisional.

** Including sale licensed by the Kenya Dairy Board.

Figure 2. Major Crop Production Zones of Kenya



grasshopper species which can become pests depending on environmental conditions.

Locusts generally do not breed in Kenya, but will migrate southward from North Africa and the Horn (or in the case of the Red Locust, northward from the outbreak areas in Tanzania). A particularly vulnerable period is during the shift of prevailing winds from southwesterly to northeasterly in September-October. At this time the resulting northeasterly winds may bring migrating gregarious swarms into northern Kenya from breeding areas in the Ogaden and along the Red Sea. At this time the locusts have access to virtually all agricultural regions of the country; the Great Rift Valley has even acted as a "throughway" for swarms as they move from northern regions to the productive agricultural lands of southwestern Kenya. There is also the possibility of breeding in northern Kenya under these circumstances, in which case an extended winter control campaign would be necessary. The pattern can be a very erratic one, with several years of intense locust infestation activity followed by ten years of virtually no locust sightings. Infestations have occurred in the 1960s and 1978, and again in 1989. Conversely, grasshoppers will be found in Kenya at varying levels of infestation every year.

3.4 Locust Management - Overview

3.4.1 Past Locust Campaigns

The three locust species discussed in this document are normal parts of the biological system in East Africa. Periodic upsurges and migrations occurred even before the introduction of extensive agriculture. With the introduction of agriculture, however, these insects, along with other species that are considered "pests," could readily take advantage of crop lands in the path of the migrations.

The Desert Locust Control Organization-East Africa was formed with UK Overseas Development Association (ODA) support in 1962 as a response by seven member East African nations to the need for a regional locust facility. It is headquartered in Addis Ababa, with a main Operations Base in Nairobi. Originally, emphasis was on survey of locust populations. In recent years new functions including training, operations research, and control (with emphasis on initial suppression of the populations) have been added. Within Kenya, the CPB is responsible for management under low infestation conditions; if survey information indicates an approaching outbreak and migration, DLCO-EA begins regional locust control and maintains close contact with CPB and the Department of Defense (DOD) in coordination of control operations, particularly deployment of aircraft and other means transportation and spray facilities.

In past locust invasions, DLCO-EA and PPD located control stations with chemicals and land and aerial application equipment at the northern Locust Control Bases of Wajir, Moyale, and Mandera. Vigorous attempts were made to achieve control in the northern portion of Kenya, before the locusts could arrive in the productive agricultural region of the southwest.

3.4.2 Crop Loss Assessment

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

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

Crop losses can vary geographically, with extreme damage occurring near areas which seem untouched. Regional information on crop productivity, l/g infestation levels, and efficacy of control efforts needs to be compiled and analyzed over a period of years in order to obtain more precise estimates of locust management program cost effectiveness. This SEA strongly urges that such data collection and analysis be undertaken.

3.4.3 Predictability/Breadth of Operations

Locust infestations are difficult to predict in advance. Rainfall distribution is influential, but locusts often occur in patterns not easily related to any obvious environmental determinant. Because of this unpredictability, surveillance is essential for designing tactics to maintain low locust populations and prevent outbreaks. As rainfall and the vegetation that follows it are important factors, remote sensing techniques and satellite-derived Greenness Maps may be useful as additional guidance to supplement field surveillance.

Field survey is essential in locust management programs, and must be given high priority by both the CPB and assisting donors. Included in the survey program must be a sound knowledge of pest biology and an understanding of the impact of environmental conditions. Survey results need to be relayed to CPB and DLCO-EA facilities in Nairobi in a timely manner, in order to allow administrators time to direct logistical operations and obtain needed materials.

Although DLCO-EA performs locust surveys and may initiate limited-scale control, the organization responsible for major control activities is the Kenya CPB. This organization has some of the expertise needed for a responsible management campaign, however, additional training programs should be considered. The CPB is responsible for planning, survey, operational control and campaign assessment, and personnel must be trained to use pesticides in a safe and environmentally sound manner.

For organizational purposes, the FAO should be considered the official donor coordinator for locust control activities on behalf of the GOK, and should be supported in continuing that role. In addition, the CPB should be encouraged to work closely with DLCO-EA, FAO and the donor community to insure that repetition of unneeded material or pesticide donations and excess stock buildup do not occur.

3.4.4 Level of Infestation

Grasshoppers and locusts vary over a range of population levels in their natural habitat, depending upon rainfall and other environmental conditions. A migrating infestation of locusts, depending upon wind conditions and movement patterns, can have a significant impact on agriculture. For grasshoppers, crop infestation levels depend upon the numeric density and life stage of the insect. In Kenya, grasshoppers may be a problem in some regions every year. Locusts, however, are widely periodic and can fluctuate greatly over time periods of five to ten years, if not longer.

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

Level 0 describes a "normal" density of grasshoppers. In Kenya, locusts are not considered at this level, as breeding populations do not usually occur. In this regard, grasshopper density levels will below the intervention threshold level for a given species. Crop losses from this level of infestation are

minor and localized. The CPB is capable of carrying out any needed treatment programs without donor assistance.

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

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

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

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

3.4.5 Thresholds of USAID Assistance

The CPB is expected to maintain an ongoing insect management program during periods of normal pest levels. This program should include efforts to reduce human health risk, protect environmentally sensitive habitats, and minimize pesticide use through use of cultural, biological and traditional means of control. In decisions on assistance to the CPB for locust or grasshopper management activities, USAID will examine both the pest situation and the capabilities of the CPB. Decisions will be made in such a way as to minimize the amount of pesticide used.

If USAID does choose to participate in an assistance program, it is important that support be coordinated with other donors and the GOK to achieve a reasonable and balanced program. Assistance for such a program should emphasize the principles of Integrated Pest Management (IPM) (as discussed in section 3.5.5), in that all available management resources should be considered. While probable crop loss will be a criterion for USAID involvement in control efforts, sustainable infrastructure development and cost/benefit ratio will also be considered. Participation by USAID in emergency operations will be carefully tempered with an examination of what long-term benefits will be

achieved in addition to an insect population decrease. Because use of pesticides in Kenya has been increasing rapidly over the last few years, USAID will assist primarily with a program emphasizing effective survey procedures and use of non-chemical control methods.

The level of USAID/Kenya participation in a l/g management program should not only be related to the extent and severity of the problem, but also to the extent such assistance will yield greater sustainability of CPB programs. The actual level of intervention assistance will depend upon a number of variables, including insect density, crop conditions, CPB response capability, environmental conditions, and the potential for a major outbreak.

Prior to implementation of l/g assistance, a thorough analysis of needs is necessary. In evaluating areas of assistance, USAID/Kenya should be responsive not only to requests of the GOK, but must further ascertain what materials the CPB and DLCO-EA already have, and what other donor-supported programs are planned or implemented. Supplying the CPB with an overburden of pesticides, unneeded materials, or poorly planned training will not assist in managing locusts or grasshoppers. In addition, an independent verification of pest identity, density, and potential impact should be made by a qualified technician prior to fund committal and allocation. In this latter regard, USAID/Kenya might request assistance from USAID/W, DLCO-EA, or FAO.

3.4.6 Disaster Level of USAID Participation

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

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

During large-scale operations, there is likely to be an increase in accidents, pesticide overuse, and application of incorrect formulations. The phenomenon is due primarily to the much greater use of pesticides and the pressure of panic treatments at these times. The most important function of the GOK under these conditions is to institute greater local control

(for example, use of Village Brigades), and to communicate effectively with the affected population. GOK will need to describe the necessity of the emergency measures, and ensure to the extent possible the safety of the population and the environment. Operations at a local level, accompanied by appropriate training in pesticide use and safety, is greatly preferred to massive treatments by large aircraft.

The position of USAID/Kenya is to support the judicious use of such chemicals for the control of food crop-threatening pests. The first line of defense must be field survey work to monitor the population level of a particular pest. Proper monitoring will generally allow sufficient time to plan a strategy of control. Survey operations will also alert officials should pests be breeding at a faster rate than expected, or if a significant migration has occurred. The second line of defense is spot treatment via ground applications. This strategy involves personnel-intensive measures to directly attack sites of the infestation at early life cycle stages of the insect. Aerial application is considered a last resort. This control measure is used when all others have proved ineffective or when the magnitude of the threat exceeds the response capacity of CPB.

3.5 Locust Management - Operations

3.5.1 Crop Protection Branch

Crop protection responsibility falls within the CPB, which is structurally within the GOK Ministry of Agriculture (MOA). Pesticide recommendations are made by the Extension Service of the CPB. An important source of information for the Extension Service is the Kenya Agriculture Research Institute (KARI), a parastatal body established in 1988, which conducts pest management research (including pesticide efficacy testing) at a number of field stations throughout Kenya. Advice is also received from commodities institutes, University Colleges at Embu and Bakura, the Egerton College of Agriculture, and the International Center for Insect Physiology and Ecology (ICIPE). CPB is capable of carrying out insect management and crop protection activities when locust or grasshopper population levels are low (levels 0 or 1, section 3.4.4). It may be appropriate to provide assistance programs to the CPB at this level, particularly in the form of training, the goals of any such assistance being to increase sustainability of the CPB infrastructure. Although action plans may be developed annually by CPB, material and equipment allocations are below those needed to control substantial numbers of swarming locusts. With vigilant survey and management programs, locusts and grasshoppers can be maintained at low population levels.

Active survey and early season management can save valuable funds and resources over the long-term, compared with costs of

short-term emergency operations. FAO and DLCO-EA have been critical sources of survey information and early intervention in this regard. However, additional donor assistance may be required if l/g infestation levels exceed the capacity of the CPB. Concerning U.S.-funded assistance involving pesticides, the information, recommendations, and regulations discussed in this SEA and the PEA must be observed and reckoned with in project design and implementation.

In the event of a threatened outbreak, the main locust control stations would be CPB/DLCO-EA bases in northern Kenya at Wajir (HQ), Moyale and Mandera. One fixed-wing DLCO-EA aircraft would be deployed at Mandera, along with appropriate logistics, pesticides, and ground team. Pesticides would be imported by manufacturers as needed, and formulation could be done by Kenya firms. Donors would be expected to supply chemicals on a regional basis with DLCO-EA indicating sites of greatest need. Pesticide stocks for locust control in Kenya are not large, and DLCO-EA anticipates a need for about 20,000 l. if a campaign needs to be mounted in the country. FAO is in the process of preparing a locust emergency contingency plan, which would act as the coordinating document for all participants in the management program.

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

3.5.2 Survey and Control Preparations

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

- Full knowledge of the physical and temporal distribution of the pest species.

- Monitoring of environmental conditions and changes which might lead to increased numbers of pest species. This will require an adequate knowledge of pest species biology, the status of environmental conditions, and how these conditions can be augmenting or limiting factors.

- A vulnerability assessment in terms of crops threatened by the pest species, including relative importance of crops, and the crop stage of development, and an understanding of the vulnerability of the human population likely to be affected.

- The availability of pest management support resources to be mobilized for control: pesticides, application equipment, as well as logistical and technical support.

Survey and monitoring personnel in Kenya include CPB staff, other government workers, and local farmers. Each of the 7 provinces has a Provincial Crops Office staffed with a Crops Officer and a team of several specialists who act as the monitoring and control team for that province. Basic stocks of application equipment, chemicals, and protective gear are kept at Provincial Offices. The Crops Officer is responsible for monitoring insect populations and reporting to CPB in Nairobi. Each district within a province has a District Crops Office. Monitoring is done at this level, as well. Personnel in the District Offices are regarded as the "frontline staff," who provide training on pesticide use and safety to the farmer. For locusts, FAO and DLCO-EA become extensively in regional monitoring.

Prior to main periods of vulnerability (Sept.-Oct.-Nov.), the DLCO-EA and CPB should ensure that each Locust Control Station and District Crops Office is equipped and prepared to face a low level (level 0 in section 3.4.4) of l/g management. Adequate preparation would include: a working radio system, operating vehicles and application equipment, protective clothing and safety equipment that are clean and ready to use, and the needed amount of pesticides carefully stored and ready for use.

3.5.3 Village Brigades

Farmers can play a major role in a control campaign -- reporting population levels to actively protecting crops from larval infestations. However, with chemical pesticides, farmer and village training programs are required. Both USAID and FAO have had a high degree of success in this area with "Train the Trainer" programs. These have been implemented on a large scale basis since 1987 in areas of Africa where locust or grasshopper infestations are endemic. The technique is applicable to the

situation in Kenya for locusts as well as other insect pests, and is encouraged by this SEA.

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

Continuing support by the CPB is essential for a Village Brigade. Once a Brigade is formed, members must receive needed materials and technical support within a reasonable time frame in order to achieve crop protection. While a trained group may in theory be able to creatively defend crops against pests without resources; in reality, they will lose both enthusiasm and expertise without support.

3.5.4 Ground and Aerial Operations

Use of spray aircraft, particularly helicopters (they are three times more expensive than fixed-wing aircraft), should be considered a last resort in a U.S.-funded locust or grasshopper management program. With an attentive survey program, combined with rapid deployment of ground pesticide application teams, it is possible to conduct an effective management campaign without spray aircraft. USAID fully supports this concept, and the needed training programs for survey and ground teams. In addition to the basics of survey techniques, pesticide safety, and application; such training must encompass a thorough background knowledge of pest species that require control.

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

The Kenya CPB has access to several fixed-wing aircraft and helicopters through Kenya DOD (2 Dorniers, undergoing repairs), DLCO-EA (2 Beavers), and FAO (3 helicopters for survey/control in the Horn) for its aerial spray operations. In addition, two commercial firms in Nairobi have aircraft which are used for

spraying herbicides (although the firms have no experience in locust control).

Aerial control operations for locusts have produced the following generalizations:

- large infested areas can be treated in a short time;
- inaccessible areas are more easily treated;
- aircraft logistical support is expensive, and large amounts of pesticides are required;
- pesticide drift is difficult to control;
- landing strips for fixed-wing aircraft require frequent and expensive maintenance.

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

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

Operational sprayer-equipped land vehicles available for a locust control program may be available from DLCO-EA (5), CPB (4) or from DOD (7 Land Rovers with sprayers, in need of repair). Maintenance and vehicle replacement is critical; much of the equipment dates from 1970's locust campaigns and is over 15 years old.

3.5.5 Integrated Pest Management - IPM.

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

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

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

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

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

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

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

Research is needed to determine the initial intervention threshold. This threshold level must be thoroughly tested and verified under actual field conditions. The level can be refined as more information becomes available, and as it is used in the field.

Step 2: Select the Best Mix of Control Techniques.

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

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

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

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

Step 3: Monitor the Fields Regularly.

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

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

Step 4: Use All Control Methods Correctly and Safely.

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

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

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

IPM is a sensible approach to pest control whereby all existing control methods (pesticides, biological control, cultural control), mitigating factors, environmental concerns, climatic conditions, and ecosystem interrelationships are

integrated to assist in control operation decision making. While pesticides are part of the total IPM strategy, other methods are considered, with the choice dependent on the methods that most closely fit the situation. Timing of pesticide application is an important factor in IPM, with the early season approach favored because of the low amount of pesticides used. IPM is not a pest control method itself, but is a way of systematically considering options available in light of the physical and biological environment.

3.6 Pesticide Management

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

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

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

- Effectiveness at low application rates;

- Minimal effects on nontarget organisms, including people and animals, and specifically predators and parasites of locusts and grasshoppers;

- Minimum persistence of residues on and in native fauna and flora, water, soil, and crops;

- Low toxicity and ease of handling;

- Good storage capacity;

- Compatibility with existing application equipment.

3.6.1 Pesticide Selection and Distribution

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

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

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

Kenya is one of the larger users of pesticides in East Africa, and has reflected annual increases in value of imported pesticide since 1986 of between 11 and 28%. In 1991, the value of imported pesticides was estimated at 24-28 million USD. The heaviest use of pesticides in Kenya is on cash or plantation crops. The small holder sector, however, is beginning to shift to a cash crop economy, e.g. horticultural crops, and is generating a higher demand for pesticides.

Pesticides in Kenya are procured through three major supply sources: manufacturing and formulation by local companies representing foreign agrochemical firms; imports by major multinational chemical companies; and donations from the

international community. The CPB is responsible for maintaining and distributing pesticide stocks in Kenya. Distribution usually takes place prior to the agricultural season, so all key management elements can be prepared for any level of infestation. The major depot is Kabete Bulk Store in Nairobi. Pesticides are distributed from there to the Provincial Crops Offices as needed. There is also extensive commercial distribution of pesticides in the private sector, with over 20 local and multinational companies formulating pesticides in Kenya.

3.6.2 Pesticide Labeling

Pesticide labeling is a way to give important information to the pesticide user. The label is the main and often only medium for instructing users in correct and safe use practices. Part of the labeling process is pesticide registration by host countries. Both registration and proper labeling require good solid legislation at the national level. The Pest Control Products Act (Chapt. 345) and subsidiary legislation requires registration of all pesticides imported into Kenya, and stipulates criteria for packaging, labeling and advertising. Pesticide testing for registration purposes often becomes the responsibility of a specific commodity organization, such as the Coffee Research Foundation. Limited resources make complete enforcement by the CPB difficult. While registration of imports is being accomplished,there is an active informal market in pesticides being brought in from neighboring countries. A strong program of enforcement of the existing licensing and labeling program by the GOK would be an important step in achieving safe use of pesticides.

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

Pesticide labeling in Kenya tends to be variable. In general, pesticides in the original container carry a label with adequate information for application. Some labels, though not all, include some information on first-aid or disposal. Unfortunately, some of the CPB-stocked pesticide containers have either lost the labels that did exist, or labels have been rendered illegible through handling and exposure.

While labeling must be specific to local needs and the social environment of Kenya, the FAO has prepared a global set of guidelines which can assist a labeling program. In addition to enforcing legislation, the GOK should insist that donated

pesticides be labeled in comprehensive language as required by donor country law.

3.6.3 Managing Pesticide Stocks

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

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

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

Success of locust and grasshopper campaigns depends on availability of pesticides in the areas which need treatment. Pesticides should be placed in a safe and secure storage area as close as possible to agricultural areas which will likely need treatment. In Kenya, pesticide storage areas are associated with the CPB District Offices. From the District Offices, a monthly inventory of products and materials should be made and sent to the CPB in Nairobi. Distribution of products to District Offices and to the DLCO-EA Locust Control Centers is done according to need and severity of the locust/grasshopper threat.

For the most part, the storage facilities in Kenya are good. Most of the CPB warehouses have been constructed within the last 10 years. Care in management must be taken to prevent unwanted stock accumulation. This has been a very real problem for other countries involved in l/g management; a lack of planning and coordination has resulted in stockpiles of pesticides at some

bases, and shortages at others. This seems to be a result of a lack of training in the managerial aspects of pesticide storage.

In addition to management of the pesticides themselves, the CPB District Offices must adequately manage pesticide application equipment. Due to inconsistent donor contributions, Kenya has accumulated several different types and brands of spray equipment. This equipment is rarely interchangeable or compatible in regard to spare parts and repair. Some of this equipment, especially that obtained for locust control, is rather old, and deterioration is a problem. Nevertheless, the CPB must work to maintain what equipment it does have, and ensure that it is clean and in good working order.

3.6.4 Obsolete Pesticides and Containers

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

Kenya, like other countries in sub-Saharan Africa, is faced with a serious problem of large stocks of expired or substandard pesticides which were acquired through commodity aid programs or unplanned importations. The situation is particularly acute at Kitengela site, in Machakos Province, which has stocks of dieldrin and BHC in liquid formulation. Drums are corroding and labels are absent or illegible. There is no policy developed which adequately covers disposal of such chemicals as well as empty containers.

3.6.5 Disposal of Unwanted Pesticides

When a pesticide is no longer needed, or is degraded chemically due to heat or time it will need to be disposed of. As the majority of the obsolete chemicals are liquid products, one disposal method is high-temperature incineration at a suitable facility. Incinerators in Europe or other countries may also be used for disposal operations. Disposal is a complex problem not yet clearly resolved in technologically advanced countries, but suitable methodology should be made available to developing countries at the earliest opportunity. Because of the current research in this area, and the potential for political ramifications, USAID/Kenya should consult USAID/W prior to any pesticide disposal assistance program.

3.7 Cultural and Biological Management

Numerous non-chemical methods exist for pest management in general, and have been used against locust and grasshoppers. For example, crop varieties which develop at different rates from the commonly planted varieties, or which show resistance to insect attack, may be applicable in the long-term. Sorghum, for example, is more resistant to attack by grasshoppers than millet. Other cultural methods, such as trap cropping, residue burning, trench digging in front of locust larval path, and intercropping may well have merit as well. Simple techniques such as using protected courtyards for tree seedling nurseries or covering seedlings with mosquito netting can be effective in small scale and limited cases.

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

Research on field use of microbial agents in locust and grasshopper control is currently being implemented by USAID and other international organizations. The fungal pathogen Beauvaria bassiana has been tested in the US and in parts of Africa for its control potential. Preliminary results from Mali indicate that B. bassiana can be an important control agent, especially if used as part of an overall biointensive program. Additional work will be needed to determine its specific usefulness on the Desert Locust in Kenya.

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

Another research recommendation is the search for local and possibly more species-specific pathogens. Large population explosions of locusts/grasshoppers might be conducive to the development of epidemics of endemic pathogens. At the time of population collapses a search for more effective pathogens would be appropriate. Such a search should be done in collaboration with laboratories familiar with pathogen isolation.

Research is needed on plant extracts as bio-pesticides and antifeedants which may have use as components of IPM and may be appropriate for Kenya. Some materials may already be used by villagers as a traditional means of insect control.

Other fruitful research areas might include use of synthetic insect growth regulators (IGR). These agents are considered alternatives to conventional pesticides because of their different modes of action, and incorporation of IGRs into the 1993 African Migratory Locust control program in Madagascar showed that the technique has promise. However, there may be impact on non-target aquatic invertebrates.

3.8 Safety and Health Care System

3.8.1 Public Awareness

In conjunction with USAID assistance in locust and grasshopper efforts, it is important that the Government of Kenya monitor both human health and the natural environment. In regard to protecting human health, it is necessary to educate both the medical community and pesticide applicators about the potential hazards of pesticides, and steps to mitigate these. Application of a pesticide in a given area should be preceded by public awareness and extension activities and education of the users. The Kenyan public must be informed that pesticides are dangerous and that empty pesticide containers should not be used for food or water storage. A good public information program would include:

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

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

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

3.8.2 General Pesticide Safety Concerns

Because of the role pesticides can play in potentially increasing agricultural productivity, the Government of Kenya regards these chemicals a useful part of agriculture. Unfortunately, pesticides can be misused by both farmers and CPB agents, presenting hazards to the human environment and the natural ecology. Some pesticides in Kenya are marketed illegally and fraudulently. Pesticides intended for agricultural or public health purposes may be misused for fishing, hunting, and general household insect control.

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

3.8.3 Applicator Safety Training

USAID has supported pesticide applicator safety training in the past in Africa, and has found such training to be a useful and often sustainable use of funds. It is important that well-trained CPB agents are available to work with any U.S.-funded pesticide donation.

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

Properly trained CPB agents and agricultural extension agents are encouraged to work with farmers and Village Brigades in "Train-the-Trainer" programs. This type of training will allow essential information on pesticide safety and application to reach all who may be working with pesticides. This type of training is strongly encouraged by USAID. For instance, GIFAP launched a Safe Use Pilot Project in 1991, and has the goal of training 400,000 farmers over a three year period. A series of on-farm workshops is designed to train some 2000 extension officers who are then to train 60 or more farmers each per year, thus reaching 120,000 farmers per year. The success of the program has been hampered by lack of motivation and resources among extension officers, and it is doubtful that the goal of 400,000 safety-trained farmers will be met by the end of the project. Thus, while it is among the most advanced training

programs in East Africa, it still falls short of providing the training necessary if farmers are to use pesticides effectively and safely.

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

3.8.4 Health Care System

Kenya's health sector consists of three major sub-sectors: public, voluntary, and private. Public services are provided by government and municipal health facilities. The voluntary sector consists of mission health services and health activities of other non-governmental organizations. Private services include medical care provided by private health institutions, fee-for-service medical practitioners and pharmacies, as well as services provided by private companies to their employees.

The government, through the Ministry of Health (MOH), is the dominant player in the health care system, providing 70% of hospital beds in a total of 88 hospitals. 61 church-related hospitals provide 21% of beds, and 43 private hospitals 9% of beds. Similarly, 76% of health centers (365) and dispensaries (1082) are run by the MOH, 14% (72 health centers and 302 dispensaries) by church-related NGOs, with the remainder (46 health centers and 215 dispensaries) managed by private providers.

The health care network in the public sector is organized at three levels, with Kenyatta National Hospital at the apex, followed by Provincial General Hospitals delivering tertiary care and acting as referral points for difficult or specialized cases. Below these are the district and sub-district hospitals which provide both inpatient and outpatient services. Below the district hospitals there are health centers and dispensaries referring patients, if necessary, to district hospitals. The network of rural facilities currently reaches only 50% of the rural population. Furthermore, those facilities that exist suffer from shortages of trained staff, equipment, and supplies. Regional health care access information is presented in Figure 3.

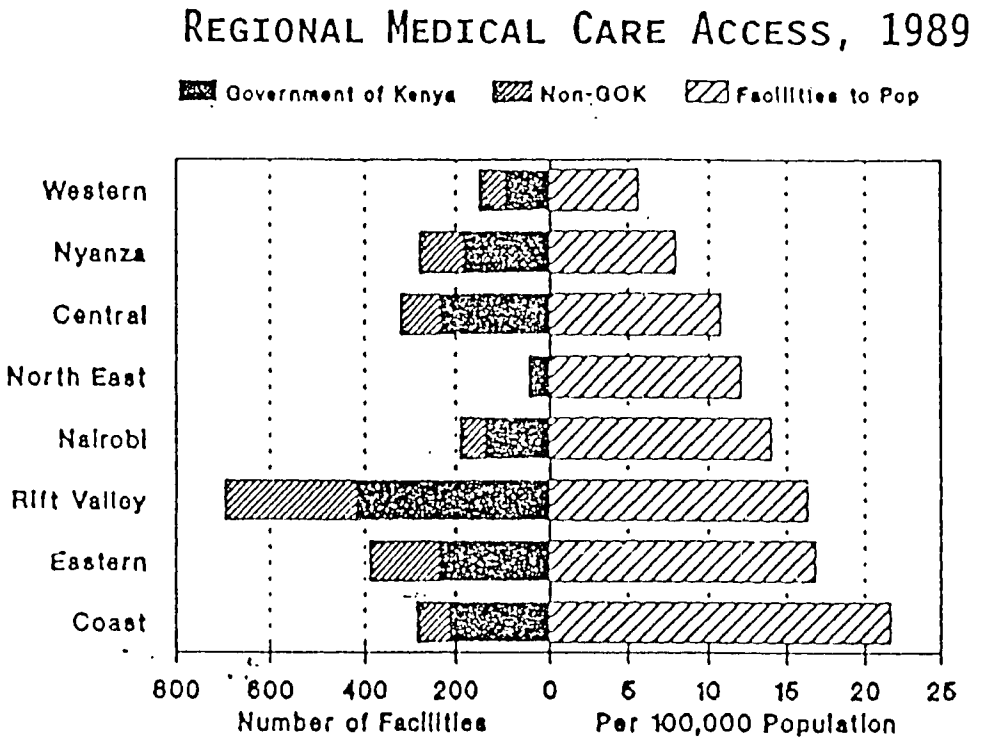
All hospitals and health centers in an area which is likely to be involved in a pesticide spray operation should be provided with information materials on the pesticides to be used in the area. The personnel of these centers should be given the necessary training to recognize and treat pesticide poisonings. Information is available in the EPA handbook on pesticide poisonings (Morgan, 1989).

The local health care delivery system in Kenya may not be equipped to handle a serious case of poisoning, which, if it occurs, is most likely to involve an applicator. Therefore, application crews need to be self-sufficient in handling medical emergencies. Supervisors must be familiar with safe handling of pesticides and be able to administer any needed first aid, including antidotes for pesticide poisoning. All who are working with pesticides should be familiar with the early warning signs of poisoning. Workers must be removed from contact with pesticides at the first signs of poisoning.

3.8.5 Potential for Human Health Impact

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

Figure 3


REGIONAL MEDICAL CARE ACCESS, 1989
Government of Kenya
Non-GOK
Facilities to Pop
Western
Nyanza
Central
North East
Nairobi
Rift Valley
Eastern
Coast
800
600
400
200
0
5
10
15
20
25
Number of Facilities
Per 100,000 Population

previous section. Another major aspect, covered in this section, is prevention of human exposure.

3.8.6 Prevention of Human Exposure

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

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

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

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

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

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

3.8.7 Monitoring of Human Exposure

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

The GOK should have the capability to monitor both behavioral symptoms of pesticide poisoning, and such blood-chemistry manifestations as acetylcholinesterase (AChE) inhibition. Testing for AChE inhibition is fairly simple and inexpensive, and can be performed by trained health workers in the field. The background cholinesterase level for each person involved with pesticides must be determined prior to exposure, and testing should be performed at intervals throughout the season to ensure that no worker is being overexposed to pesticides. (It should be noted that testing AChE is recommended only when pesticides in the organophosphate class are used, e.g Malathion, Sevin, etc.)

Measurement of residue levels in the environment can also be a valuable source of information for assessing exposure and determining if modifications to treatment operations are needed. At present, the PCB is dependent on technical documentation to evaluate non-target effects of pesticides. There is concern about analysis of pesticide residues, but there is a lack of adequate facilities in Kenya. ODA/KARI provided a laboratory at the NAL (National Agricultural Laboratory), but this facility is used mostly for formulation analysis and not for residue determination. Other organizations, e.g. Coffee Research Foundation, Kenya Bureau of Standards, and the Faculty of Veterinary Medicine, have analytical laboratories, but none are available to the PCB. This SEA supports development of such a facility, perhaps on an East Africa regional basis, as data are lacking on pesticide degradation under local conditions and on residue persistence on food crops.

3.9 Environmental and Non-target Impact

3.9.1 Environmental Impact Minimization

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

Because of the additional risks incurred in late season control operations, USAID/Kenya should support management operations designed to avoid such risks. Early season survey and management can prevent late season control operations, with significantly less pesticide usage. Preventive management operations emphasizing surveys which locate and delimit pest populations, and spot treatment operations intended to reduce population numbers using as little pesticide as possible are favored.

Because the number of hectares sprayed is reduced, early season control operations use less fuel. Vehicle wear is also reduced and vehicles will last longer. Because early season control strategy uses considerably less resources, CPB can be better able to implement it without donor assistance. A greater degree of self-sufficiency and control of the situation by CPB itself is allowed.

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

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

Although this SEA strongly recommends against any pesticide applications in aquatic systems, only safer pesticides which are

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

3.9.2 Environmental Monitoring

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

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

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

A similar monitoring approach should be used for pesticide use in terrestrial ecosystems. Selection of soil microorganisms or other low-tolerance invertebrates as indicator species is recommended. Monitoring animals of economic value or threatened status should also be required. In cases where pesticide persistence is an issue, residues should be measured. Populations of vertebrate predators, such as birds or prey, are likely to fluctuate too much to make population counts an effective monitoring tool. However, reproduction monitoring of carnivores (e.g., observations of egg conditions, birth defects, infant mortality) may be a useful tool in determining the effects of pesticides known to affect reproductive success, particularly in cases where baseline data are known.

4.0 PROTECTED AREAS/PROTECTED ANIMALS AND PLANTS

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

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

Two major projects are currently underway which are concerned with protection of fragile areas and conservation of biodiversity. USAID/Kenya (AGR) and KWS have involvement in both: USAID/Kenya's Conservation of Biodiverse Resource Areas (COBRA) Project and the World Bank-funded Protected Areas and Wildlife Service (PAWS) Project. This SEA recommends that mitigative measures associated with any l/g control activity be coordinated with USAID/Kenya's present activity in both projects.

Kenya has a diversity of lake, river, fish farming, and coastal fishing resources. Lake Victoria is reported to produce over 180,000 metric tons of fish per year. Lake Turkana is also an important fisheries resource. Fish as a protein source

support much of the population in both regions, and provide livelihood to fishermen and people in associated industry. Fish populations are liable to be indirectly affected by pesticides used in locust or grasshopper control operations because of direct toxicity to aquatic invertebrate fauna (Keith, 1989). As Lake Turkana is located in the north of the country, those fisheries may be especially at risk as locust control efforts are implemented.

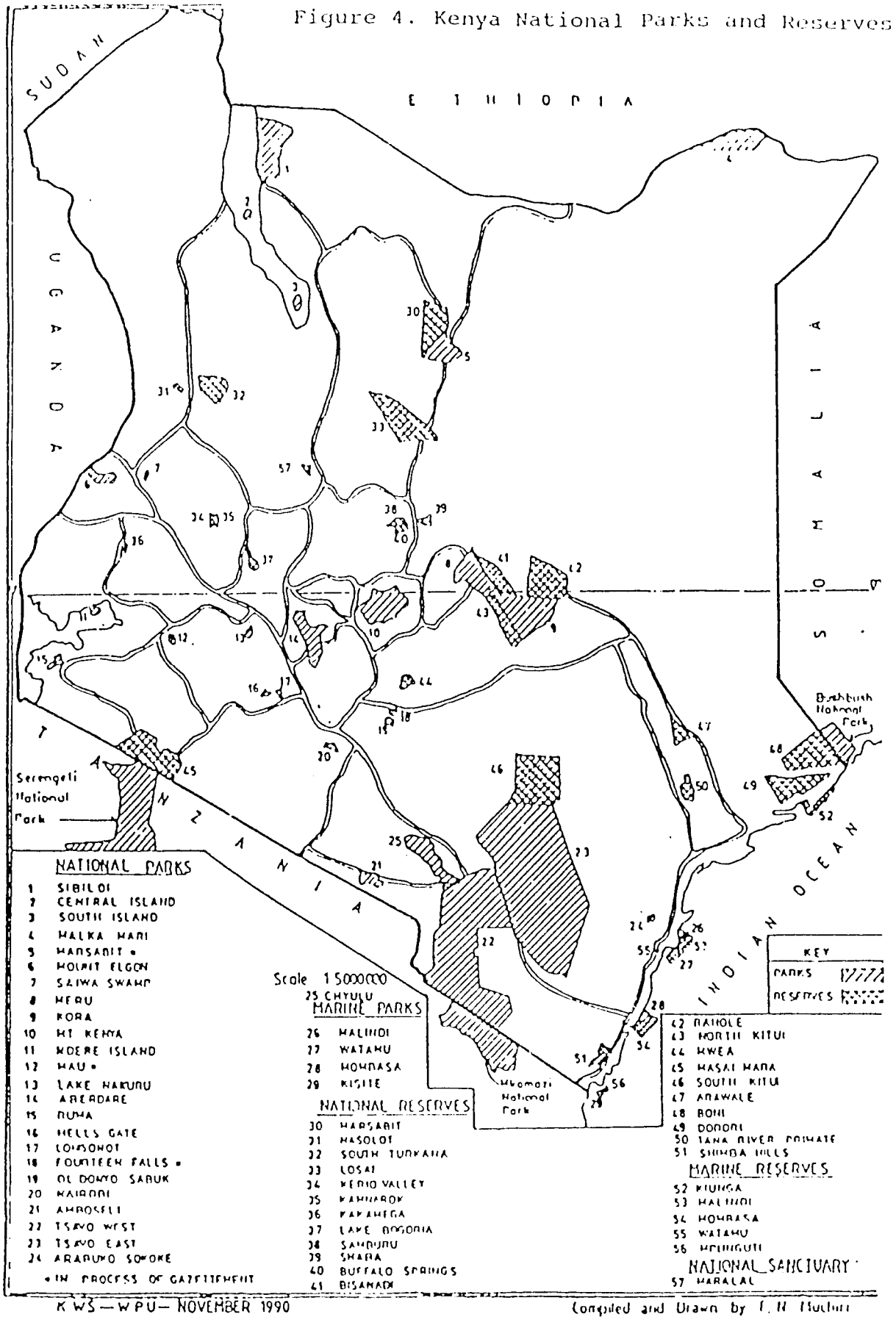
Unfortunately, population pressure and basic economic needs are contributing to degradation of forests and grasslands in Kenya, and habitat for many of Kenya's plant and animal species is being lost. Drought and erosion further accelerate this habitat deterioration. **It is extremely important that any U.S.-funded l/g control program involving pesticides not contribute further to the environmental degradation already underway. Further, the United States should do its utmost to use methods and materials that have the least toxic effects on both crop and natural ecosystems.**

4.1 Protected Areas

Kenya has 44,562 km^2, approximately 8% of its land area, officially designated as National Parks or Reserves. There are presently 57 protected areas: 29 National Parks, 27 National Reserves, and one National Sanctuary. Figure 4 shows both the parks and the game conservation areas which are considered important for survival of wildlife resources in the country. The most important game reserve is the Masai Mara, the northern extension of the Serengeti ecosystem in Tanzania, seasonally holding hundreds of thousands of wildebeests, zebra, and other large ungulates.

These parks and reserves are habitat for a wide variety of plains and forest mammals, ranging from herbivores such as various antelopes, giraffes, zebras, elephants, rhinos, and buffaloes to predators like lions, cheetahs, and various wild cats and hunting dogs. In addition to these regions, there are the numerous Rift Valley lakes with their diverse and abundant bird life. It is critical to consider the importance of these habitats, and the direct vulnerability of birds to pesticide toxicity, in implementing any locust or grasshopper control operations involving pesticide spraying. The environments are responsible for the great importance of the tourist industry to Kenya's economy. Tourism accounts for 88% of visits to Kenya, compared with only 12% for business or other purposes.

Figure 4. Kenya National Parks and Reserves



KWS—WPU—NOVEMBER 1990 Compiled and Drawn by I. N. Muchiri

1,338,000 ha. of protected forest are owned by the GOK. In addition, there are 412,000 ha. of forest owned by various City Councils and 124,000 of private forests. Existing legislation in theory protects the forests and the National Parks located within some of them from cultivation, poaching, or illegal settlements, but adequate enforcement remains a problem.

Protected areas should be surrounded by a buffer zone at least 2.5 - 5.0 km wide. These are needed to avoid accidental pesticide application and possible spray drift, and will help to minimize indirect effects of pesticide use. Within buffer zones, higher priority should be given to use of alternatives to chemical pesticides, and a monitoring program so that non-chemical alternatives can be applied successfully. As the capacity of the CPB to provide training in non-chemical alternatives increases, the width of the buffer zones can be increased.

4.2 Non-Protected Sensitive Areas

In addition to these protected areas, the CPB should take precautions in a number of other areas that have a lower level of vulnerability, but which are still ecologically sensitive. The protected areas are not self-sufficient ecosystems, and wildlife moves in and out seasonally. The wildlife migration corridors need to be considered, as do large regions outside the park and reserve system which also harbor considerable wildlife. These areas can be designated as high priority areas for Village Brigade mobilization, intensive monitoring, and encouraging non-chemical methods of control. The areas would also include buffer zones around all territories designated above as fully protected zones, given their sensitivity to indirect effects.

Wetlands are particularly fragile environments, and only a few (Lake Nakuru, Lake Bogoria, the Amboseli basin) have been designated as protected areas. Coastal and nearshore areas including mangroves and coral reefs represent an important resource as breeding grounds for fish and aquatic invertebrates (and as tourist attractions). Major rivers (Sabaki, Tana, Nzoia, Molo) provide water for wildlife and human use, and support fisheries. Permanent swamps such as those at the mouth of the Tana River, the Yala and Nzoia entry points into Lake Victoria, and the northern edge of Lake Naivasha, are highly productive, providing food and cover for a rich biological community of animals and plants, many of them important to local economies. Seasonal wetlands, including flood-plains and swamps, cover wide areas of the eastern part of the country (e.g., Tana basin) and provide vital breeding, rearing, and feeding habitats for numerous species of migrating wildlife. The saline or alkaline lakes (e.g., Turkana, Nakuru, Elementaita) are generally highly productive, supporting large populations of birds and important

fisheries. In 1990, Kenya joined the Ramsar Convention, which conveys an obligation for the environmentally sound management of all wetlands.

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

4.3 Protected Animals and Plants

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

Many populations of endangered and threatened species continue to decline despite legislation. Several animal species may cease to exist unless a considerably higher level of protection can be brought to bear. Any U.S.-funded operation must consider the potential impact of pesticides on these already strained habitats and the flora and fauna contained therein. While the value of human life cannot be placed below that of an endangered species, the U.S. should not allow itself to be drawn into a situation that may force such a choice. Here again, early survey and surgical treatment programs can allay such situations.

4.4 Pesticide Alternatives in Sensitive Areas

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

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APPENDIX A
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APPENDIX B

Analysis of PEA Recommendations

PEA for LOCUSTS/GRASSHOPPERS: SYNOPSIS OF ENVIRONMENTAL ASSESSMENT PRIORITIES

BASIC PRE-CONDITION OF PROGRAM

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

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

INVENTORY AND MAPPING PROCEDURES

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

This recommendation can be part of future USAID/Kenya involvement with assistance efforts. Maps should include specific areas to be protected, some with a total ban on pesticides for grasshopper or locust control and some with a high priority for restricted use of pesticides. Areas which may have potential for the testing of pesticide alternatives should also be included.

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

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

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

A plan for managing obsolete stocks has been drafted with the support of USAID Washington. This should include the

periodic testing of stored pesticide stocks to insure that the material is usable. Unwanted stocks in Kenya should be disposed of only with technology that best fits the local situation. High priority should be placed on minimizing the future accumulation of any unwanted pesticide.

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

This SEA supports that recommendation as a USAID/W-coordinated and supported activity.

MITIGATION OF NON-TARGET PESTICIDE EFFECTS

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

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

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

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

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

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

population numbers, and behavior should be made at locations involved in pesticides use.

APPLICATION OF INSECTICIDES

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

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

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

The treatment program in Kenya should emphasize early season ground application. However, during rainy season treatment operations, road conditions may necessitate the use of aircraft. In addition, some areas may not be accessible except by helicopter. The USAID/W (Forest Service) Aerial Application Guidelines should be followed in any such operation.

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

This SEA supports this recommendation. However, large aircraft may be needed in Kenya to spray areas far from supportive infrastructure.

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

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

integrated with USAID-provided technical assistance.

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

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

DISPOSAL OF PESTICIDES

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

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

PUBLIC HEALTH AWARENESS

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

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

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

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

Recommendation 17. It is recommended that each health center and dispensary located in an area where pesticides are used be provided with posters describing diagnosis and treatment of pesticide poisonings, as well as medicines and antidotes required for treatment of poisoning cases.

This SEA supports this recommendation, and advocates collaboration between the PPD and the Ministry of Health in appropriate implementation.

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

This SEA supports the need to monitor the health of pesticide applicators and handlers during control operations. It is especially feasible to monitor blood cholinesterase in individuals working with organophosphate pesticides. This should be implemented on a regular basis with pesticide handlers and applicators. In addition, this SEA favors behavioral monitoring for symptoms of pesticide exposure.

PESTICIDE FORMULATION AND MANAGEMENT

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

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

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

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

BIOLOGICAL CONTROL

Recommendation 21. It is recommended that <u>Beauveria</u> and other biological agents such as plant extracts be field tested under

African and Asian conditions in priority countries.

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

TRAINING

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

This SEA supports that recommendation for Kenya. The L/G Operations Handbook (USAID, 1989a) fills this need in part, as does the PEA and this SEA. Other materials include regional meetings and workshops, and short-term technical assistance.

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

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

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

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

ECONOMICS

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

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

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

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

ENVIRONMENTAL POLICY

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

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

PESTICIDE USE POLICY

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

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

PESTICIDE HANDBOOK

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

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

SUPPORT AND TRAINING

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

This SEA supports this recommendation, but only with a thorough analysis of actual needs, existing supportive infrastructure, and the ability of the PPD to manage a sustainable I/g management program.

STORAGE

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

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

FORECASTING

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

This SEA is in favor of continuing and improving forecasting as an USAID/W or FAO activity.

PUBLIC HEALTH MONITORING AND STUDY

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

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

RESEARCH

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

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

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

Several plant extracts in Kenya are worth investigating for bio-pesticide activity, thus deserving additional field research. As additional funds are available, the most promising options should be pursued.

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

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

ENHANCING AND ACCELERATING IMPLEMENTATION

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

This SEA supports this recommendation. USAID/W has a general plan of action that includes the development of Supplementary Environmental Assessments in the countries that are

most critical for locust and grasshopper control. These countries include Burkina Faso, Cameroon, Chad, Madagascar, Mali, Mauritania, Niger, Senegal, Sudan, and now Kenya and Ethiopia. These SEAs will, in turn, contain commitments for future actions. Country-specific plans of action will be developed to implement those commitments when needed. Such a plan for Kenya is being developed by the CPB in coordination with FAO. The country-specific plans of action will be the backbone for guidance of locust/grasshopper control activities.

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

This SEA supports this recommendation. Coordination must occur both at the USAID/W level and the USAID/Kenya level. In Kenya, the CPB would not be the major coordinating body, and donors need to discuss specific plans with each other. These efforts should be improved for the future.

APPENDIX C.

Documentation that can be consulted on safety measures, transport, distribution, handling, use, application, and disposal of Pesticides.

FAO Pesticide Management Documents:

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

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

c) Guidelines for pesticide disposal and container disposal.

d) List of FAO approved pesticides.

e) Pesticide storage and packaging guidelines.

f) Guidelines for pesticide approval and management.

g) Ecotoxicological guidelines.

h) Ground and aerial application guidelines.

i) Insecticide poisoning: prevention, diagnosis and treatment.

j) Guidelines for effective labeling.

k) Efficacy requirements for pesticide approval.

l) Guidelines on environmental criteria for the registration of pesticides

Other Documents on Pesticides and Locust/Grasshopper Control:

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

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

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

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

e) Locust/Grasshopper and Control - Interministerial

Instruction No. 3 related to protection of man and environment. Algérien doc.- March 1989.

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

USEPA Pesticide Fact Sheets:

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

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

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

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

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

FINAL ACTION FORM

COUNTRY: KENYA

DATE: November 1993

Recommendation: Approval. WIK

ACTION TAKEN:

Approved: ✓ Date 12/9/93

Disapproval: _____ Date _____

Bureau Environmental Officer, John Gaudet: [signature]