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ENVIRONMENTAL IMPACT ASSESSMENT OF AFRICAN ARMYWORM CONTROL IN ETHIOPIA: AN AMENDMENT TO THE SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT OF LOCUST/GRASSHOPPER CONTROL IN ETHIOPIA

AFRICAN EMERGENCY LOCUST AND GRASSHOPPER ASSISTANCE (AELGA) PROJECT

NOV. 1994

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EXECUTIVE SUMMARY

PREPARING AN ENVIRONMENT IMPACT ASSESSMENT OF AFRICAN ARMYWORM CONTROL IN ETHIOPIA: AN AMENDMENT TO THE "ETHIOPIAN SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR LOCUST/GRASSHOPPER CONTROL"

The 1994 African Armyworm (AAW) outbreaks in Ethiopia most likely originated in Tanzania in January 1994. From March through May 1994, AAW moths migrated from Tanzania to Kenya and Uganda. Moths from Kenya probably migrated to Ethiopia. In Ethiopia, the first outbreaks were reported from Borena on April 18, 1994. The outbreak then spread to eastern Ethiopia. By the end of May the outbreak spread throughout Ethiopia, with the exception of the Afar region. The Government of Japan, the Swedish International Development Agency (SIDA) (through DLCO/EA), the Government of Korea, and FAO provided the Government of Ethiopia (GOE) with pesticides for armyworm control. The Swiss Government participated in the control effort by donating funds for hiring aircraft. The Governments of Norway and the Netherlands covered some of the costs incurred for air lifting pesticides to the Tigray region. The outbreak ended in August 1994.

The Ethiopian Ministry of Agriculture (MOA), requested pesticides from USAID and other donors to control the AAW outbreaks. Since USAID lacked an environmental impact assessment for armyworm control in Ethiopia, USAID regulation 22 CFR 216.3(b)(1) prohibited USAID from providing pesticides or donating funds that would be used in conjunction with pesticide application activities. The USAID Mission in Ethiopia sent representatives to the United Nations Emergency Unit for Ethiopia (UN/EUE) meetings on the armyworm outbreaks. According to the Food and Humanitarian Assistance (FHA) staff at the Mission, the Mission did not participate in AAW control operations, or provide any support. However, MOA used chlorpyriphos, provided in 1993 by USAID for locust control, to control AAWs.

To allow USAID to deal with AAWs in the future, AELGA sent Dr. Gary Jahn, an entomologist to Ethiopia to prepare an amendment of the "Supplemental Environmental Assessment for Locust/Grasshopper Control in Ethiopia". During his TDY, he interviewed members of MOA, DLCO/EA, and the Tigray Regional Agriculture Bureau (TRAB). He also inspected fields formerly infested with AAW and inspected the pesticide storage facilities of MOA, DLCO/EA, and TRAB.

During the 1994 AAW outbreak the most serious problems were a shortage of pesticides, a shortage of safety equipment, and a shortage of vehicles. All of these needs were met by donors with the exception of providing adequate safety equipment. According to TRAB, less than 10% of the pesticide applicators had respirators or other safety equipment. Many vehicles were loaned

to regional bureaus by local NGOs.

The MOA, the Regional Agriculture Bureaus, DLCO and FAO maintain that there is a severe pesticide shortage in Ethiopia. MOA estimates that there is currently a total of about 100,000 liters of pesticides in 43 storage sites in the country. If this figure is correct, it is not a large supply compared to the 275,391 liters and 60,331 kg of pesticides applied for armyworm control in Ethiopia this year. MOA is in the process of updating the national pesticide inventory.

Most pesticide storage facilities in Ethiopia were not constructed specifically for storing pesticides and are deficient in some respects. Dr. Andrew Harvey's AAW report to FAO suggests that the solution to the problem of pesticide shortages and poorly constructed facilities in Ethiopia is to provide Ethiopia with four new buildings designed specifically for pesticide storage. However, it may be premature to place pesticide warehouses in Ethiopia. The quality of pesticide management in Ethiopia varies widely. While the MOA and DLCO pesticide storage facilities in Addis Ababa are in excellent condition, the facility in Mekele was not properly maintained. At the TRAB Mekele facility 50 barrels of pesticides were stored with a barrel of airplane fuel, old furniture, and other flammable material. Goggles were covered with dust and only one, very old respirator was available. MOA, TRAB, and DLCO all maintain stocks of expired pesticides. Currently there are no pesticide registration laws in Ethiopia. MOA has formed an advisory board to develop registration laws. When the registration laws are in place and enforced, when all pesticide facilities are properly managed, when a national pesticide inventory exists, and when the expired pesticide stocks have been destroyed it will be appropriate to consider creating pesticide warehouses in Ethiopia. Ethiopia is already moving in the right direction with regard to pesticide safety. It would be a shame to jeopardize this progress by overloading the system with too many pesticide stocks to properly manage. At the present, it would be wiser to create a pesticide bank in Europe, where pesticides could be moved into Africa on short notice as needed.

The 1994 AAW outbreak was brought under control and large amounts of grain were apparently saved from destruction, though there are no estimates available of the amount of grain saved.

RECOMMENDATIONS

A. Research

1. Develop formulations of nuclear polyhedrosis virus (NPV) for control of AAW. NPV is much safer to humans and the environment than pesticides.
2. Conduct field trials of commercial formulations of <u>Bacillus thuringiensis</u> (B.t.), an insecticidal bacteria, to determine if any of them provide adequate AAW control. B.t. is more

host specific than conventional pesticides, is biodegradable, and is non-toxic to humans.

3. Develop formulations of B.t. isolates shown to be effective against AAW, e.g. B.t. isolate K-26-21.
4. It is unlikely that predators or parasites could be utilized to combat an outbreak. However, research should be conducted to determine if natural enemies can reduce AAW populations at the centers of origin, thus preventing outbreaks.
5. Find out what happens to the AAW that migrate to the north. Do they eventually return to the south? Do they only exist in the north at low populations after initial outbreaks? If so, why do northern population fail to develop into gregarious forms that migrate again?

B. Training

1. Pesticide training for applicators provided by MOA consisted of demonstrations, lectures, and film presentations. Training programs could be improved by making them more participatory in nature, i.e. having trainees actually use the spray equipment and safety equipment during training.
2. The Regional offices in Tigray conducted training in pesticide use and safety for farmers. Since there was a shortage of respirators, farmers were told to wrap cloth around their faces to protect themselves from breathing in pesticides. Unfortunately, when cloth becomes wet with pesticides it acts as a wick and draws pesticides toward the applicator's face. Donors should only provide pesticides in conjunction with adequate amounts of safety equipment.

C. Strategic plans

1. Prevent outbreaks by controlling AAW before they reach Ethiopia.
2. Tigray and Eritrea were warned by MOA of the AAW outbreaks in Southern Ethiopia. This gave TRAB, the northern provinces, and Eritrea about 2 weeks to prepare for the infestations. The regions and Eritrea should be continuously informed of the status of AAW in Kenya though DLCO and the Ethiopian Ministry of Agriculture.

D. Pesticides

1. Do not stockpile pesticides in Ethiopia at this time.
2. Provide Ethiopia with pesticides on an "as-needed" basis for AAW, just as is done for locusts.
3. Support the development of a Pesticide Bank in Europe so that donors, international pest control institutes, and African governments can be prepared for major pest outbreaks.
4. Provide Ethiopia with a large stock of safety equipment, particularly respirators, so that MOA can provide farmers with respirators as easily as they provide farmers with pesticides.

I. LITERATURE REVIEW OF SPODOPTERA EXEMPTA, THE AFRICAN ARMYWORM

A. Biology and Ecology

The African armyworm (AAW), Spodoptera exempta (Walker) (Lepidoptera: Noctuidae), larvae feed on all types of grasses, early stages of cereal crops (e.g., corn, rice, wheat, millet, sorghum), sugar cane, and occasionally on coconut (Odiyo 1984; Yarrow et al. 1981). The armyworm gets it's name from it's habit of "marching" in large numbers from grasslands into crops. AAWs tend to occur at very high densities during the rainy season, especially after periods of prolonged drought (Haggis 1984, 1986). During the long dry season in eastern Africa AAW population densities are very low. Because outbreaks are never observed during the dry season, it is called the "off-season" by those that monitor AAWs (Odiyo 1981).

S. exempta moths live about 10 days. The female can lay a maximum of about 1000 eggs in her lifetime. Eggs hatch in 2-3 days. Six larval instars are completed in 2-3 weeks. Larvae occur in two morphologically distinct forms: a 'gregarious' form, which is black with yellow stripes, and a solitary form, which is green or brown. The morphological form is determined by density -- becoming 'gregarious' at higher densities. However, the AAWs do not exhibit the true gregarious behavior of locusts. It is the gregarious forms of AAW that cause outbreaks. Generally, AAWs are not noticed by farmers until the caterpillars are 10 days old and change from green to black (Brown 1972). In the last instar, larvae burrow 2-3 cm into the ground to pupate. Adults emerge in 7 to 10 days (Dewhurst 1985). The moths, migrate over tens, and probably over hundreds, of kilometers between their emergence sites and their oviposition sites (Riley et al. 1983). The observation that AAW outbreaks can suddenly occur in areas that were free of the pests for several months has lead to the hypothesis that the moths migrate hundreds of kilometers. Evidence for this hypothesis includes:

1) outbreaks in a geographical progression at one generation intervals (Rainey 1979);
2) outbreaks are often preceded by high catches of moths and associated with wind convergence (Blair et al. 1980);
3) results of isozyme analysis imply that AAW populations in Kenya, Tanzania, and Zimbabwe regularly inter-breed (Den Boer 1978);
4) laboratory tests show that the moths can remain in flight for several hours (Gatehouse and Hackett 1980);
5) results of mark and capture studies, and radar tracking indicate long distance, downwind migration of AAW moths (Rose et al. 1985).

There is a trade-off between flight and reproduction, i.e. longer the moths fly, the lower their fecundity (i.e.,

reproductive potential) (Gunn et al. 1989; Gunn and Gatehouse 1993). The moths tend to fly downwind and infest new areas in regions of wind convergence (Brown et al. 1969; Tucker et al. 1982). There are three distinct periods of flight activity each night for moths: dusk, late evening, and just before dawn (Rose and Dewhurst 1979). Migratory flights begin the night of emergence; or newly emerged moths congregate in trees and mass migration flights begin at dusk the following night (Riley et al. 1983).

During seasons when there are no outbreaks, the AAW persists in it's solitary phase (in which caterpillars remain green, are less active, and therefore less conspicuous). The first outbreaks of the season probably result from concentrations of moths before the synchronized mating and egg laying (Pedgley 1989; Rose 1979). These outbreaks frequently follow periods of prolonged drought. Janssen (1992, 1993) found that plant's have more nutrients than usual, especially nitrogen, following the first rain after a drought. While these nutritional differences may account for increased AAW moth fecundity, this has not been demonstrated. An alternative, and untested, explanation for outbreaks following droughts is that the effectiveness of predators and parasites in regulating population growth may be significantly reduced through droughts (Marcovitch 1957).

It has been suggested that the outbreaks may result from synchronized ending of pupal diapause, as opposed to mass migration. However, no diapausing pupae have ever been found in the field. Diapause in a small proportion of pupae has been observed in the laboratory (Khasimuddin 1977).

B. Distribution

S. exempta is found throughout Africa south of the Sahara, with large infestations concentrated in the eastern half of the continent. The center of AAW breeding is around the Mozambique-Zimbabwe area. Outbreaks progress from this area into 30 African nations, from Mauritania and Senegal in the north-west to Ethiopia and Somalia in the north-east, and to Namibia and South Africa in the south (Odiyo 1984). AAW also occurs in south-western Arabia, and intermittently in the oceanic countries of South East Asia and the Pacific as far east as Hawaii, but not in the Americas (Haggis 1984, 1986). The species is found as far south as Australia and New Zealand (Commonwealth Institute of Entomology 1972).

C. Damage

An infestation of AAW covering 65 square km2 of rangeland with a larval density of 28/m2 consumes about 50 tons (dry weight) of herbage per day during their final instar. This feeding rate is equivalent to that of 8000 head of cattle (Odiyo

1979).

D. Control

1. Forecasting

African armyworm moths are monitored using pheromone traps that attract sexually receptive males. Light traps, Aldis beam observations, radar, and optical infra-red observations are also used to track the movement of the moths and improve forecasting ability (Tucker 1983). Dewhurst (1985) recommends controlling AAWs with insecticides in the first larval instar, thus preventing their northward spread. Control strategies could be improved by determining the conditions that lead to concentrations of moths. If moth concentrations could be located and destroyed, then outbreaks could be prevented (Pedgley et al. 1989).

2. Biological control

There is tremendous potential for biological control of AAWs. According to Dewhurst (1985), viruses can control AAWs under suitable, but restricted, conditions. In an effort to use viral control, farmers around the world have attempted to control caterpillars by collecting dead caterpillars from the field, grinding them up, mixing them with water, and spraying the mixture on threatened crops. The mixture is sometimes referred to as the "green milkshake." The green milkshake is highly unreliable as a control method. If the farmers are fortunate enough to find caterpillars infected with pathogenic viruses, if the virus are not degraded by enzymes in the grinding process, if the viruses are not rapidly degraded by sunlight, and if the virus can be transmitted orally, the green milkshake can be very effective; but a good deal of luck is needed. Even when the green milkshake works, the potency of the shake tends to decrease with each successive formulation.

The Plant Protection Bureaus of Thailand have modified the green milkshake technique with some success. There, S. exigua are reared in government laboratories. A certain portion of the caterpillars are regularly infected with nuclear polyhedrosis virus (NPV). Infected caterpillars are harvested at the peak of the virus population and ground into the green milkshake. The green milkshake is distributed to farmers. By collecting the dead caterpillars from their fields, farmers are generally able to successfully re-create the green milkshake 2 or 3 times. After that, the potency is too low to be effective and farmers must be re-supplied with laboratory stock. Another drawback is that infectivity rates tend to be low, so large quantities of virus must be used. The rate of infectivity can be greatly enhanced by formulating NPV with adjuvants to provide protection from sunlight. For example, the addition of Tinopal, an optical brightener to NPV adjuvants prevents degradation of NPV by ultra-violet radiation, increasing the virulence of NPV to S.

frugiperda 164,000 to 303,000 times (Hamm and Shapiro 1992).

Bacteria can also be used to control Noctuid caterpillars. Bacillus thuringiensis (B.t.), an insecticidal bacteria, has reduced AAW populations by 95% in field trials. The literature is filled with seemingly contradictory results when it comes to controlling Spodoptera with B.t.. This is because the insecticidal activities of various B.t. strains differ with the target pest species (Belda and Guerreo 1992; Jarret and Burges 1986; Lecadet and Mortouret 1987). Brownbridge (1991) screened 150 B.t. strains for insecticidal activity against AAWs. B.t. strain K-26-21, isolated from soil in Kenya, showed the highest level of toxicity to AAWs in the laboratory. In field trials, isolate K-26-21 provided almost total control of larvae on maize seedlings within 48 hours. In this experiment, ants and spiders played a significant role in suppressing the AAW population, especially early instars. Natural enemy populations were not effected by the B.t..

It is not known to what extent natural enemies keep AAW populations in check. A proposed sampling plan for AAW in maize cannot be used where natural enemies are most efficient and keep the AAWs at very low densities (Schulthess et al. 1991). Ants are known to significantly reduce S. frugiperda populations and associated damage in maize. Reducing applications of broadspectrum insecticides, or replacing them with biological insecticides, such as B.t., allows ants to contribute to Spodoptera control (Perfecto 1990).

3. Antifeedants

The pyrrolidine 2(R), 5(R)-dihydroxymethyl-3(R), 4(R)-dihydroxypyrrolidine (DMDP) deters feeding in S. exempta as well as in the locusts Schistocera gregaria (Forsk.) and Locusta migratoria L. (Blaney et al. 1984; Fellows et al. 1989; and Simmonds et al. 1989 cited in Simmonds et. al. 1990). Due to incomplete coverage, antifeedants alone are rarely sufficient to protect a crop. However, antifeedants can be an important part of an IPM program.

4. Pesticides

Several pesticides are used for AAW control, including malathion, endosulfan, cypermethrin (a pyrethroid), carbaryl, fenitrothion, and chlorpyriphos (Appendix 1 p. 6; Brown et al. 1970; Hewitt and Meganasa 1993; Wheatley and Crowe 1967). Insect growth regulators (IGRs) have only been used experimentally so far. In laboratory studies IGRs have been shown to significantly increase the mortality of another species of armyworm, S. frugiperda. The addition of a feeding stimulant to the IGR increases its effectiveness (Chandler 1993).

When spraying AAWs with cypermethrin the optimal droplet size is 35 microns diameter or more. Field trials in Kenya

indicate that a minimum of nine droplets of 2.4% ULV formulation of cypermethrin per square centimeter is required for 50% AAW kill, whereas 95% mortality requires at least 28 droplets per square centimeter. To achieve 50% AAW mortality requires track spacing of 25 m for back-mounted sprayers and 45 m for vehicle-mounted sprayers. As the track space is decreased, the AAW mortality increases (Hewitt and Meganasa 1993).

II. THE 1994 AFRICAN ARMYWORM OUTBREAK

The 1994 AAW outbreaks in Ethiopia most likely originated in Tanzania in January 1994. Moths may have migrated from Tanzania to Kenya and Uganda in March. From late March through May there were AAW outbreaks in the Coastal, Nyanza and Rift Valley provinces of Kenya. These outbreaks were monitored by the Desert Locust Control Organization (DLCO) and sprayed by the Kenya Plant Protection Department (Appendix 10). Moths from Kenya probably migrated to Ethiopia. In Ethiopia, the first outbreaks were reported from Borena Zone, Teltele Wereda on April 18, 1994 (Appendix 7). Initial infestations in southern Ethiopia were followed by small outbreaks in central Ethiopia. It is possible that the moths detected in Ethiopia resulted from primary outbreaks originating in southern Ethiopia. In May 1994, the northeastern third of Ethiopia, the provinces of Tigray and Wello, suffered widespread severe outbreaks. In all, 1,267,451 ha. were infested with armyworm in Ethiopia. Of these, 882,419 ha were crop land and the remainder pasture land (Appendix 4). The Government of Japan, the Swedish International Development Agency (SIDA) (through DLCO/EA), the Government of Korea, and the United Nations Food and Agriculture Organization (FAO) provided the Government of Ethiopia (GOE) with pesticides for armyworm control. The outbreak ended in August 1994.

Reports from 5 Ethiopian regions indicate that at least 159,671 ha of crop land was destroyed by armyworms. Out of this, 121,157 ha or 75.9% of the land was replanted with early maturing crops.

III. ORGANIZATIONS INVOLVED IN ARMYWORM CONTROL IN ETHIOPIA

A. USAID

The Ethiopian Ministry of Agriculture (MOA), requested pesticides from USAID and other donors to control the AAW outbreaks. Since USAID lacked an environmental impact assessment for armyworm control in Ethiopia, USAID regulations [22 CFR 216.3(b) (1)] prohibited USAID from providing pesticides or donating funds that would be used in conjunction with pesticide application activities (Appendix 8). The USAID Mission in Ethiopia sent representatives to the UNEUE & UNDP/FAO meetings on the armyworm outbreaks. According to the Food and Humanitarian Assistance (FHA) staff at the Mission, the Mission did not

participate in AAW control operations, or provide any support. However, according to Mrs. Haimanot Abebe, Head of the MOA Crop Protection Division and according to members of the MOA Pesticide Registration Advisory Committee, MOA used chlorpyriphos, provided in 1993 by USAID for locust control, to control AAW. Interviews with Mr. Brehane Hailu, Head of the Tigray Regional Bureau of Agriculture, and with Mr. Ibrahim Fitiny, team leader of the Trigray Plant Protection Department, confirmed that USAID pesticides were used in the armyworm control operations.

The Food and Humanitarian Assistance (FHA) program of the USAID Mission in Ethiopia would prefer not to deal with AAW outbreaks as emergencies or disasters, since AAW are a seasonal occurrence, and it may be possible to prevent outbreaks through monitoring, forecasting, and preventive measures. FHA would prefer to see the African Emergency Locust/Grasshopper Assistance (AELGA) program deal with AAW on a regular basis.

The USAID Africa Bureau Environmental Officer sent a memo (Appendix 2) to AFR/AA/DRC chief to instruct AELGA to amend the "Supplemental Environmental Assessment for Locust/Grasshopper control in Ethiopia" to include armyworm control. To allow USAID to deal with AAW in the future, AELGA sent Dr. Gary C. Jahn, an entomologist, to Ethiopia to prepare this amendment.

B. National Crop Protection Departments

The structure of the Ethiopian Ministry of Agriculture (MOA) down to the department level is shown in Appendix 5. Each department is divided into divisions. The Crop Protection Division, which dealt with the armyworm outbreaks, is in the Agricultural Development & Crop Protection Department. This consultant requested that MOA provide an organization chart for this department. Although promised, the chart was never given to this consultant.

The consultant met with Mrs. Haimonot Abebe, head of the Crop Protection Division; Dr. Abdurhaman, MOA senior entomologist and chair of the Pesticide Registration & Control Advisory Committee (PRCAC); and Mr. Samuel Ketema, MOA pesticide application specialist, entomologist, and member of the PRCAC. The PRCAC is a new office and not yet fully functional. To date, Ethiopia has no pesticide registration laws. The PRCAC is attempting to develop a cohesive government policy on pesticides.

The Crop Protection Division was responsible for coordinating AAW control operations through the regional crop protection units that report to the provincial governments. MOA distributed pesticides and spraying equipment to all outbreak areas. MOA distributed over 140,000 liters of pesticides to the regions before the outbreak occurred. Each regional bureau is autonomous and responsible for pest control activities in the

region (regions are shown in Appendix 6). Based on recommendations from DLCO, MOA requested pesticides from donors which could be used on locusts and grasshoppers as well as armyworms (Appendix 8). MOA requested:

Carbaryl 85% WP	40,000 Kg
Malathion 50% EC	40,000 Lt.
Fenitrothion 95% ULV	50,000 Lt.
Chlorpyriphos 24% ULV	50,000 Lt.

Carbaryl, malathion, and fenitrothion have been used by GOE for many years for AAW control. MOA only began using chlorpyriphos for AAW in 1993 based on the recommendations of FAO and DLCO.

GOE received all the requested pesticides and also received diazinon (an organophosphorus (OP) insecticide), trichlorfon (an OP), and cypermethrin (a pyrethroid). The Japanese government donated 49,800 liters of pesticides under KR2 1992 and 88,600 liters of pesticides under KR2 1993. The Republic of Korea donated 38,800 liters of pesticides. GOE procured 719 knapsack sprayers from the Ethiopian Regional Relief Program (ERRP). Although it was not MOA's intention, using a variety of insecticides for AAW control is a good strategy for avoiding the development of pesticide resistance in AAWs. Appendix 4 contains a complete list of the type and quantity of the pesticides distributed to the regions for the 1994 AAW outbreak.

Spray aircraft and pilots were provided to MOA by the Ethiopian Airlines Spray Service (formerly called Admass Air) and by DLCO/EA. This consultant visited the Ethiopian Airlines hangers to inspect the aircraft and interview pilots. Ethiopian Airlines spray service has two types of planes: Turbo Thrush and Agcat. Both types of aircraft use Micronair ULV sprayers. Several of the aircraft have computerized flow-rate regulators. All of the pilots wear protective clothing (i.e. respirators, helmets, and coveralls). All DLCO planes are Beaver aircraft. The only other aircraft in the country with spraying ability belong to Ahmesh Inc., a private firm which uses the aircraft for spraying its own fields. Fenitrothion 96% technical and malathion 95% technical were the pesticides applied by air. Approximately 30 tons of pesticide were applied by the aerial spraying campaign nation-wide.

C. Pesticide Regulatory Bodies

In 1994, MOA formed a Pesticide Registration Advisory Board consisting of experts on health, the environment, agriculture, and pests. These experts are drawn from departments throughout the government. As of Nov. 1994 the Board was in the process of creating a complete inventory of the 43 pesticide storage sites in Ethiopia. There are no pesticides registered in Ethiopia yet. The registration guidelines are being formulated by the Board. Currently the Board lacks legislative authority.

D. Desert Locust Control Organization of East Africa (DLCO/EA)

The DLCO/EA has an AAW unit which monitors the movement of armyworms. DLCO/EA provided MOA with: 6 Land Rovers; 30 drums of AV gas; 25 drums of insecticide (Fenitrothion); one aircraft for the control of AAWs in Hararghe, Dire Dawa, and Tigray (Appendix 4).

E. Donor Agencies

The Swiss Government donated $38,000 for hiring air craft from the Spray Service Unit of Ethiopian Airlines. The Government of Norway donated $6,500 to airlift pesticides to the Tigray Region. The Government of the Netherlands also donated $8,234 to airlift pesticides and equipment to the Trigray Region. There was one million Birr left over from donations that SIDA had made to DLCO/EA for locust control. SIDA directed DLCO to use the fund to purchase 32,800 liters of pesticides locally from AISCO for the MOA for AAW control. AISCO is an Ethiopian government owned organization that purchases pesticides in bulk from abroad to sell to Ethiopian farmers at a reasonable price. AISCO does make a profit from pesticide sales. In addition, SIDA provided $50,000 through DLCO-EA for hiring air craft from the Spray Service Unit of Ethiopian Airlines.

GOE also used pesticides which the Japanese and Korean governments regularly donate, i.e. the pesticides were not provided specifically for the 1994 AAW outbreak.

F. NGOs

REST, TDA, GTZ, World Vision, and NACID provided the Tigray Regional Agriculture Bureau with vehicles for the AAW control operation.

G. United Nations

Through UN-EUE, the UNDP provided $50,00 for hiring the services of migratory pest consultants and for extending the contract for the Spray Service Unit of Ethiopian Airlines.

FAO donated $250,000 for the purchase of an international consultant, technical backstopping, official travel, general operating expenses, pesticides, sprayers, protective clothing, communications equipment, and direct operating expenses. However, according to the Tigray Regional Agriculture Bureau (TRAB), less than 10% of the pesticide applicators had adequate safety equipment.

IV. AFRICAN ARMYWORM CONTROL

A. Control Operations of 1994

1. Forecasting

Current "forecasting" methods for Tigray and other regions consist of monitoring for male moths within the region using pheromone traps. In Assbe Teferi, the pheromone traps caught more than 1,000 moths every night between 23 and 29 May. When the moths are detected it means that armyworm infestations will begin within a matter of days. There are only seven pheromone traps in the entire Tigray region. The pheromone trap data from Tigray is sent to the MOA in Addis Ababa. MOA sends the data onto DLCO in Addis Ababa and Kenya.

MOA notified the Ministry of Information a week after the first outbreaks of the year were detected in Ethiopia on April 18, 1994. MOA claims that they notified all Ethiopian regional bureaus and even Eritrea when the first outbreaks occurred. The Tigray Regional Agriculture Bureau (TRAB) maintains that they were never informed of the outbreaks in southern Ethiopia, and only knew of the armyworm outbreaks a few days in advance based on their own pheromone trap collections. According to the Eritrean Department of Agricultural and Rural Development, the Ethiopian Ministry of Agriculture did not inform Eritrea of the April AAW outbreaks until June.

Based on the data collected by DLCO, the 1994 AAW outbreak in Ethiopia could have been predicted months in advance. The northern regions would have had time to prepare for the outbreak if the flow of information had gone from south to north. When MOA receives the information from DLCO, MOA should immediately notify the regional bureaus and Eritrea. When TRAB detects moths in pheromone traps, they should inform Eritrea as well as MOA. Just as DLCO notifies Ethiopia and Kenya of locust breeding in Eritrea, so too should DLCO notify Eritrea and northern Ethiopia of AAW outbreaks in Tanzania, Kenya, and southern Ethiopia.

2. Pesticide applications

Chemical control was undertaken mainly on crops, while mechanical control was used primarily on grassland. Only 5.4% of the chemically treated area was grassland.

Pesticides were applied to 366,414 ha. About 95,000 ha or 25.9% were treated by air. Carbaryl, malathion, chlorpyriphos, diazinon, trichlorfon, and cypermethrin were applied on the ground. Fenitrothion, malathion, and chlorpyriphos were applied from the air. A total of 275,391 liters and 60,331 kg of pesticides were applied in Ethiopia in this operation.

3. Mechanical and cultural control

Mechanical control consists of using cattle to trample infested grazing land, and beating infested grass with sticks. The beating of grass is reported by the Tigray Regional Agriculture Bureau to be quite effective. Grass beating operations covering over 11,550 hectares involved over 263,590

people and over 244,880 cattle. Farmers in Tigray brought chickens to infested sites to feed on armyworms.

B. Future directions

MOA plans to:

1. Strengthen the forecasting system by having more pheromone traps and by training more operators capable of collecting trap data.
2. Reduce pesticide application rates by finding optimal rate through field trials.
3. Use more 24% chlorpyriphos for ground operations, since MOA staff believe it is safer than 50% malathion or 96% fenitrothion.
4. Continue to store expired pesticides as there is no disposal capacity.
5. Continue sprayer maintenance training.

MOA does not have any plans to conduct research on alternatives to pesticides for AAW control, but they will continue to encourage mechanical control.

C. Environmental Impact of the 1994 AAW Control Operations

The GOE did not conduct an environmental impact assessment in conjunction with the control operations. No pesticides were applied to sanctuaries or wilderness areas. There were no reports of human health impacts in treated areas, though there was no GOE program to look for such effects. Likewise, there were no reports of birds, fish, or mammals being killed by the pesticides, but GOE made no effort to look for any dead animals. The only reported environmental impact came from bee keepers, who claimed that the treatments caused the death many honey bees.

V. AREAS OF CONCERN IN THE 1994 AAW CONTROL OPERATION

A. Main Problems

1. Pesticide and equipment shortage

During the 1994 AAW outbreak the most serious problems were a shortage of pesticides, a shortage of sprayers, a shortage of safety equipment, and a shortage of vehicles.

2. Need for a national pesticide inventory

Without a national pesticide inventory it is difficult for GOE to determine how much pesticide is needed for outbreaks of AAW, locusts, or other pests. According to MOA, Ethiopia has less than 100,000 liters of useable pesticides in the country as of Nov. 1994. In addition to the useable pesticide shortage, GOE must also contend with a large stock pile of expired pesticides. The Pesticide Registration & Control Advisory Committee (PRCAC) were unable to tell this consultant how many liters of expired

pesticides are in Ethiopia. PRCAC is in the process of creating a national pesticide inventory. According to PRCAC, MOA does have an inventory of spray equipment. However, they did not have this inventory on hand and promised to send it to USAID.

3. Inadequate warning system

Outbreaks were not always reported in a timely manner. According to MOA, when the information on outbreaks went out to the regions, the response was often inadequate. According to the TRAB, the information never arrived. The equipment shortage and an inadequate warning system combined to delay control operations. In several cases, control was too late to save the crop (Appendix 11).

4. Inaccessibility of some outbreak areas

Heavy rains and poor road conditions made it difficult to distribute pesticides, sprayers, and safety equipment to remote regions.

5. Personnel shortage

A personnel shortage in some of the newly opened woredas (i.e., districts) impeded effective control operations.

6. Damage to honey bees

Aerial control operations in Trigray killed many honey bees.

7. Lack of ground survey

Ground surveys for AAW rarely preceded aerial spraying. In some instances local farmers said that fields were sprayed after the caterpillars had already pupated. However, in other instances it was thought that aerial spraying saved the crop.

8. Excessive use of pesticides

Apparently all insecticides were applied at a droplet size of 240 microns, which resulted in excessive application of all pesticides. For example, the recommended droplet size for fenitrothion is 100 microns and for cypermethrin is 35 microns. Furthermore, fenitrothion 96% was applied at 0.5 to 1 liter/hectare rather than the recommended 0.25 to 0.5 liter/hectare.

9. Misuse of pesticides

Fenitrothion 96% was distributed to the extension service for ground spraying, while malathion 50% was used in some aerial operations. Fenitrothion 96% ULV is specifically designed for aerial ULV application. Using the malathion 50% on the ground would have made more sense. If the fenitrothion 96% is the only pesticide available for ground ULV application it should first be diluted to 25% to 50%.

B. National Capacity of Ethiopia

1. Pesticides

The MOA, the Regional Agriculture Bureaus, DLCO and FAO maintain that there is a severe pesticide shortage in Ethiopia. However, a complete pesticide inventory for Ethiopia does not exist. The MOA is in the process of creating such an inventory. The Ethiopian Pesticide Registration Advisory Board estimates that there are 43 pesticide storage facilities within the country holding 100,000 liters of useable pesticides.

2. Facilities

a. Pesticide Storage

Most, if not all, pesticide storage facilities in Ethiopia were not constructed specifically for storing pesticides. Many storage facilities are deficient in some area. Dr. Harvey's report to FAO (Appendix 3) suggests that the solution to the problem of pesticide shortages and poorly constructed facilities in Ethiopia is to provide Ethiopia with four new buildings designed specifically for pesticide storage. According to Dr. Harvey these buildings would then be used to hold pesticide stocks so that Ethiopia would be pre-positioned for the next armyworm outbreak. However, the current Ethiopian storage practices, the stocks of expired pesticides, the absence of pesticide registration laws, and the lack of a national pesticide inventory indicate that placing large amounts of pesticides in Ethiopia at this time is premature. In the event that there is not another armyworm or locust outbreak for five years, the GOE will be forced to deal with an unmanageable amount of expired pesticides. Since Ethiopia lacks the facilities to properly dispose of pesticides, expired stocks pose a serious risk to health and the environment. The quality of storage practices varies greatly with the organization in charge of storage. As of Nov. 1994 the GOE is in the preliminary stages of developing pesticide regulations. This progress should not be hindered by overloading the nation with a surplus of pesticides.

I) DLCO/EA

The DLCO pesticide store in Addis Ababa has been almost completely depleted by the armyworm outbreak. As of Nov. 1994 the store contained only 30 barrels of insecticides (fenitrothion and malathion). The pesticides were stored properly and the facility was maintained in excellent condition.

II) Ethiopian Ministry of Agriculture

This consultant inspected two pesticide stores that MOA maintains outside Addis Ababa. Both stores were in excellent condition and safety procedures were being followed. All personnel entering the facility are given a clean respirator to wear. The only problem at these warehouses was that old pesticides were stored in the backs of the buildings while new pesticides were placed in front. Staff explained that they re-arrange the inventory once in a while to place older material toward the front. A simple solution would be to place a back

door on the warehouses. Pesticides could be loaded into the front door and removed from the back door, so that the oldest pesticides would be used first.

III) Regional agriculture bureaus

The TRAB pesticide warehouse contains 50 barrels of insecticides (fenitrothion and malathion) along with several hundred kilograms of DDT dust. In general the facility was safe in that there were no leaking pesticide containers. However, a barrel of AV gas, old furniture, and other flammable items were stored with the pesticides. Application equipment and safety goggles were left lying around, covered in dust and oil. Only one respirator was available and it was so clogged with dust that it was not functional. TRAB staff conceded that they had received new respirators from FAO, but that they had distributed all of them.

b. Other facilities

A number of new buildings are being constructed at TRAB. Assuming they can be equipped and staffed, TRAB will have quarantine facilities, laboratories, and classrooms rivaling those of the USDA.

VI. CONCLUSIONS

The 1994 AAW outbreak was brought under control and large amounts of grain were apparently saved from destruction, though no agency has estimates of the amount of grain saved. Several problems hindered the operation:

1) Poor communication from DLCO and MOA to Tigray & Wello Regional Agriculture Bureaus and to Eritrea.

Proper communication would have given the Bureaus more time to prepare for the outbreak.

2) Improper monitoring.

Bureaus in Tigray rely on pheromone traps in Tigray to act as sentries for an outbreak. Likewise, each region in Ethiopia relies on monitoring its own region to predict outbreaks. Reliance on regional monitoring (i.e. limited to a single province) makes sense for non-migratory pests, but not for migratory pests such as locusts or African armyworms.

3) A shortage of vehicles, aircraft, safety equipment, application equipment, and pesticides.

All Regional Agriculture Bureaus of Ethiopia, DLCO, the MOA, and FAO claim a severe shortage of equipment and pesticides. It would be interesting to tabulate the total number of vehicles donated to Ethiopia for agriculture activities. Likewise, one wonders what becomes of the safety equipment that seems to be donated to the country almost every year. Unlike pesticides, equipment is not "used up." The pesticide shortage is probably

real, though difficult to verify. No one, not even MOA has a complete inventory of the pesticide stocks in the country. With such a lack of information it is difficult to understand how MOA concluded that they have a severe pesticide shortage.

VII. RECOMMENDATIONS

A. Research

1. Develop formulations of nuclear polyhedrosis virus (NPV) for control of AAW.
2. Conduct field trials of commercial formulations of B.t. to determine if any of them provide adequate AAW control.
3. Develop formulations of B.t. isolates shown to be effective against AAW, e.g. B.t. isolate K-26-21. To obtain K-26-21 contact Dr. Michael Brownbridge of the International Centre of Insect Physiology and Ecology (ICIPE), P.O. Box 30772, Nairobi, Kenya.
4. While ants and other predators are known to reduce armyworm populations it is unlikely that predators or parasites could be utilized to combat an outbreak. However, research should be conducted to determine if natural enemies and pathogens can reduce AAW populations at the centers of origin, thus preventing outbreaks.
5. Find out what happens to the AAW that migrate to the north. Do they eventually return to the south? Do they only exist in the north at low populations after initial outbreaks? If so, why do northern population fail to develop into gregarious forms that migrate again?
6. Devise a means of killing the AAW pupae.
7. Develop transgenic plants that incorporate the gene for B.t. toxin to protect crops from AAW.
8. Identify egg parasites of AAWs. Such parasites could prevent outbreaks.

B. Training

1. The pesticide use & safety training for applicators provided by MOA consisted of demonstrations, lectures, and film presentations Training programs could be improved by making them more participatory in nature, i.e. having trainees actually use the spray equipment and safety equipment during training.
2. Pesticide storage managers at the regional bureaus need to be trained in how to handle pesticide stocks (Appendix 9).
3. Have a training course in which the operation and purpose of the trap network is explained, and reporting procedures are taught.

C. Strategic plans

1. There should be plans for preventing outbreaks by

controlling AAWs before they reach Ethiopia.

2. The Ethiopian regional agriculture bureaus and the Eritrean Ministry of Agriculture should be continuously informed of the status of AAWs in Kenya through the DLCO/EA and the Ethiopian Ministry of Agriculture.
3. Improve timely identification of occasions when concentrations of moths can occur, e.g. following droughts.
4. Expand the pheromone trap network to improve monitoring, particularly in southern Ethiopia.
5. Have planned responses to possible monitoring outcomes.

D. Pesticides

1. Do not stockpile pesticides in Ethiopia at this time.
2. Provide Ethiopia with pesticides on an "as-needed" basis for AAW, just as is done for locusts.
3. Support the development of a Pesticide Bank in Europe so that donors, international pest control institutes, and African governments can be pre-positioned for major pest outbreaks.
4. Provide Ethiopia with a large stock of safety equipment, particularly respirators, so that the GOE can provide farmers with respirators as easily as they provide farmers with pesticides.
5. USAID can provide GOE guidance on developing pesticide regulations concerning registration, storage, use, and disposal.
6. Test old pesticide stocks to determine which ones are useable and which ones are actually expired. The expiration date on the pesticide container is merely an estimate. Pesticides generally last longer than their printed expiration date. Those pesticides found to be viable should be used as quickly as possible.
7. The Regional offices in Tigray conducted training in pesticide use and safety for farmers. Since there was a shortage of respirators, farmers were told to wrap cloth around their faces to protect themselves from breathing in pesticides. Unfortunately, when the cloth becomes wet with pesticides it acts as wick and draws pesticides toward the face. Donors should only provide pesticides in conjunction with adequate amounts of safety equipment.
8. Until substitutes for pesticides are found, MOA should continue to use a variety of insecticides for AAW control, rather than relying on a single insecticide. Using a variety of pesticides helps avoid selecting for pesticide resistance in AAW.
9. Place a front and back door on all pesticide storage buildings. Use one door for storing pesticides and the other for removing them. This way the oldest pesticides will be used first without having to constantly re-arrange the inventory.
10. In the event that USAID provides pesticides to Ethiopia for

AAW control, a technical expert should be sent to Ethiopia during the control operations to assure proper storage and use of the pesticides; and to verify that ground surveys for the pest are conducted prior to aerial spraying.

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APPENDIX 1. Emergency Assistance for Armyworm Control. A project proposal from the Ethiopian Ministry of Agriculture, with a cover letter from FAO. July 15, 1994.

AGR-4

联合国粮食及农业组织
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION
منظمة الأغذية والزراعة للأمم المتحدة

OFFICE OF THE FAO REPRESENTATIVE IN ETHIOPIA
P.O. BOX 5536 TEL. 517233 FAX. 515266

FAOA -1041/94
TCP/ETH/4454(E)

July 15, 1994

Dear Mr. Michael,

Representatives of donor Agencies present during the Armyworm steering Committee meeting held on 12 July 1994 realizing the severe problem of armyworm out break, requested a project proposal from Government for Armyworm Control Operation which would provide the justification for requests made for assistance.

To this end, the Plant protection Division of MOA, has prepared the attached project proposal "Emergency Assistance for Armyworm Control" for your consideration.

The proposal presents the current status of the operation to control the spread of the infestation as well as requirements for controlling second generation outbreaks of armyworm in Northern Ethiopia. In addition, a training component has been included which brings the total project resource requirements up-to US$2.3 Million.

Your favorable consideration for financing the elements indicated in the attached proposal would be appreciated.

This office will keep you informed of the time and place of the next meeting of the committee.

With best regards,

Yours sincerely,

Marjorie Smith-John
Acting FAO Representative in Ethiopia

Mr. Michael Harvey
Food Peace Officer
USAID
Addis Ababa

FHA

Country:	Ethiopia
Project Title:	Emergency Assistance for Armyworm Control
Starting Date:	July 1994
Completion Date:	December 1994
Government Agency Responsible for Project Execution:	Crop Protection Division, Ministry of Agriculture
Donor Contribution:	US$2,321,230

Signed on behalf of the Government

Signed on behalf Donor

Date of Signature:_____

Date of Signature: _____

I. BACKGROUND AND JUSTIFICATION

Agriculture is the backbone of Ethiopia's economy. It provides employment for about 88% of the population and generates about 90% of the country's export earnings. However, at present agricultural production in the country is low: due to several factors such as drought, crop pests, etc.

The African armyworm, Spodoptera exempta is one of the most destructive insect pests in the country. It is also known as a very serious pest in the eastern central and southern African countries. It causes considerable damage to cultivated crops of the grass family (Graminae) and rangeland grasses. In Ethiopia, the crops attacked by the African armyworm include: maize, sorghum, millet, wheat, barley and tef (Eragrostis tef). It also causes considerable damage to pasture grasses. The extent of damage caused by the African armyworm depends mainly on the growth stage of the crop during attack. If the crop is attacked at the early stage of development, total crop loss may occur. If, however, the crop is attacked past early stage of development, the damage suffered may be slight and the plant can recover fully or partially depending on the rainfall situations.

Previous studies of armyworm infestations in eastern Africa indicate that the first seasonal outbreaks occur in Central Tanzania sometimes between November and January from there successive generations of adult moths fly north-wards with the prevailing winds arriving in Kenya about December or February and reaching southern Ethiopia in April or May. Outbreaks may continue until July or August in Central Ethiopia and sometimes as late as September or October in northern Ethiopia. Recent outbreaks also indicate that primary outbreaks may originate in southern Ethiopia when the environmental condition is favourable.

II. CURRENT ARMYWORM SITUATIONS

The current armyworm outbreak started on 18 April 1994 in southern Ethiopia in Teltele woreda of the Oromya region. This was followed by further outbreaks in the eastern Hararghe and Bale zones in early May. By late May the outbreak spread throughout the country with the exception of Afar region and a few highland areas. According to the information received from the various regions, 988,643 ha in 38 zones and 294 woredas were affected by the armyworm outbreak. Current outbreak was considered the worst ever recorded in the country. This is probably due to favourable ecological condition which occurred after a prolonged dry spell. The other feature of the current outbreak is its occurrence throughout the country at the same time. In the past, the occurrence of armyworm outbreak was first in southern Ethiopia in April or May, then in the central part from June to July and finally in the northern part around August to September.

Realizing the magnitude of the current armyworm outbreak, the Government has taken every possible measures that should be taken. Over 140,000 lt/kg of various types of pesticides were distributed to all regions that would be affected. 49,800 lt. of pesticides donated by the Japanese Government under KR II 92 grant and 38,800 lt/kg of pesticides donated by the Republic of Korea were also distributed in the various regions affected. In addition, 32,800 lt of pesticides procured from the fund donated by SIDA was also distributed in the outbreak areas. Similarly over 7,400 pieces of knapsack sprayers, 50,000 pieces of dry cell batteries and over Birr 1 million were sent to the different regions to cover operating expenses. 719 knapsack sprayers procured from ERRP program were also distributed to armyworm outbreak affected areas. The Swiss Government has also participated in the control program by donating funds to be used

for hiring spraying aircraft. Similarly, the Norwegian Government covered some of the costs incurred for air lifting pesticides to Tigray region. The UN emergency unit played a valuable role in mobilizing resources required for armyworm control. Control measures were undertaken using pesticides on crop land and traditional control methods such as beating the caterpillars with stick and driving livestock on the caterpillars on the grazing land. Such strategy has proved economically sound and environmentally safe. According to the report received up to July 10, 1994, control measure was undertaken on 180,663 ha. using 158,563 lt and 35,901 kg of various pesticides. Out of this 4,200 ha were treated in the eastern Hararghe zone and Dire Dawa Administrative region by the Desert Locust Control Organization for Eastern Africa (DLCO-EA) spraying aircraft and 16,600 ha in Tigray region by DLCO-EA and Admas aircrafts. The ground and aerial control operation is still underway in the Tigray region.

III. ASSISTANCE REQUIRED

A network of pheromone and light traps established by the Ministry of Agriculture indicates the occurrence of re-infestation in the coming few weeks in the northern part of the country, particularly in the Tigray region north and south Wollo as well as north and south Gondar zones of regions three. In the Tigray region the area that could be affected by the second generation armyworm outbreak as estimated by the region's Ministry of Agriculture Bureau is over 55,000 ha. Similarly, the area that is at risk in the north and south Wollo, north and south Gondar zones has been estimated to be over 85,000 ha. Totally, the area that could be threatened by the second generation armyworm outbreak is estimated to be over 140,000 ha. These areas are already badly affected by drought, and the Government is undertaking massive food and program in the area. In light of this development, further armyworm outbreak which

would deteriorate food supply situation in area. Moreover, the ecological conditions in the northern and eastern part of the country is also considered favourable for the occurrence of locust outbreaks. Unless the necessary preparations are made ahead of time the country would not be in a position to tacle the problem.

The pesticides that were stocked to assist farmers in the drought affected areas have been already exhausted for the control of first generation armyworm outbreaks. Consequently, the Ministry of Agriculture has no pesticide at hand to control second generation armyworm outbreaks and other chronic pests in the region. Hence, the Transitional Government of Ethiopia (TGE) requests external assistance to prevent food losses that are likely to occur due to pest outbreaks.

The type and quantity of pesticides, spraying equipment and safety devices required for armyworm control program and the proposed distribution list are [illegible] [illegible]

[illegible] the Ministry of Agriculture. Details are shown in Annex 3.

BEST AVAILABLE DOCUMENT

IV. EXECUTING ORGANIZATION

The Crop Protection Division of the Ministry of Agriculture will be responsible for the proper distribution of the inputs. This Division will also be responsible in ensuring the safe use of pesticides in order to protect the users and the environment from the undesirable effects of pesticides.

The Desert Locust Control Organization for Eastern Africa (DLCO-EA) will also participate in the control operation through the provision of spraying air craft(s). Additional spraying aircraft(s) can be hired either by donors or the Government from the Ethiopian Airlines when the need arises.

ANNEX 1.

EMERGENCY ASSISTANCE REQUIRED FOR ARMYWORM CONTROL IN ETHIOPIA

ITEM	UNIT	QUANTITY	ESTIMATED UNIT PRICE US$	TOTAL
1. Insecticides				
Carbaryl 85% WP	Kg	69,000	12	828,000
Malathion 50% EC	Lt	38,400	6	230,430
Fenitrothion 96% ULV	"	30,000	10	300,000
Chlorpyriphos 24% ULV	"	30,000	10	300,000
Sub - total				1,658,430
2. Spraying Equipment				
Knapsack sprayer	Pcs	1,000	50	50,000
ULV sprayer	"	4,000	40	160,000
Motorized knapsack	"	500	800	400,000
AU - 8000 sprayer	"	50	60	3,000
Sub - total				613,000
3. Safety Device				
Overall	Pcs	500	20	10,000
Gloves	"	500	10	5,000
Goggles	"	500	10	5,000
Sub - total				20,000
4. Communication Equipment				
ICOM VHF air band (108 - 130 mhz) digital	"	6	800	4,800
Total				2,296,230

DISTRIBUTION LIST OF THE EMERGENCY ASSISTANCE DONATED
FOR ARMYWORM CONTROL

Tigray	Region 3	Region 4	Southern Ethiopia PP	Region 2	Region 5	Region 6	Region 12	Region 13	Dire Dawa	Total
2,000	15,000	15,000	15,000	2,000	3,500	3,500	2,500	-	3,500	59,000
1,200	8,400	8,400	8,400	1,200	1,600	1,600	1,200	1,200	1,200	38,400
1,000	8,000	8,000	8,000	-	1,000	-	-	-	1,000	30,000
1,000	8,000	8,000	8,000	-	1,000	-	-	-	1,000	30,000
150	200	200	200	40	50	50	30	30	50	1,000
500	500	500	500	-	300	-	-	-	300	4,000
80	100	100	100	20	20	20	20	10	20	500
10	15	15	15	-	5	-	-	-	-	50
										50
25	100	100	100	20	25	25	15	15	25	500
25	100	100	100	20	25	25	15	15	25	500
25	100	100	100	20	25	25	15	15	25	500

BEST AVAILABLE DOCUMENT

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ANNEX 3

TRAINING PROGRAM

MIGRANT PEST CONTROL IN ETHIOPIA

There will be five short term training courses for plant protection and extension service personnel from the Ministry of Agriculture as follows:

Location:

1.	Bahir Dar:	Gondar, Wollo, Gojjam and North Shewa
2.	Mekelle:	Tigray
3.	Dire Dawa:	Region 5, Eastern/Western Hararghe
4.	Awassa:	Southern region
5.	Jimma:	Western Region

Duration of courses:

4 days in each of the locations.

Number of participants in each course: max. 25

Audio visual aid required:

2 Overhead projectors
2 Slide projectors
2 Screens
2 TV sets
2 Video recorders
2 Black boards

Publications and handouts

1. The African Armyworm
2. A Guide to migrant pest management

These publications are available with DLCO-EA in Nairobi/Kenya

Equipment for field demonstration

4 Motorized knapsack sprayers and AU 8000
4 Knapsack sprayers
4 Micron ULV handheld sprayers
2 EN sprayer mounted on Landrover/pick up different pesticides formulations
10 Protective clothing

Certificates 130

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BEST AVAILABLE DOCUMENT

Program

Day 1 Lectures

" General introduction to migrant pests in Eastern Africa.

" The African Armyworm:

1. Identification
2. Life cycle and recognition
3. Preparation
4. Population dynamic
   (a) primary outbreaks
   (b) secondary outbreaks
   (c) seasonal movements

Afternoon

Practical:
- identification of armyworm
- demonstration of ..... traps

Lecture:
- forecasting and monitoring
- reporting (forms, radio network)
- discussion

Evening Film on armyworm

Day 2 Lecture:

1. Control
   (a) strategic control
   (b) pesticides
   (c) application equipment (ULV, EC dust)
   (d) formulation
   (e) applying pesticide in the field (application techniques)
   (f) calibration

Afternoon Practical:
- demonstration of different sprayers
- calibration of spray equipment
- use of protective clothing

Day 3 Lecture
- pesticide safety/handling
- first aid
- damage, damage assessment and techniques used
- discussion

Afternoon

Other migrant pests

- Desert Locust
- African Migratory Locust
- Quelea birds

These lecturers should in brief explain the biology, ecology and management of the above pests.

Evening Films

Day 4

- discussion
- text - handout of certificates
- participants return to their region.

APPENDIX 2. Amendment of the SEA for locust/grasshopper control to allow African armyworms to be dealt with in East Africa. A memo from John Gaudet, Bureau Environmental Coordinator (AFR/SD/PSGE) to Paul Novick, Director (AA/AFR/DRC). August 9, 1994.

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
AFRICA BUREAU
Office of Sustainable Development
Division of Productive Sector Growth and the Environment
AFR/SD/PSGE
Washington, D.C. 20523-0089

MEMORANDUM August 9, 1994

TO: Paul Novick, AA/AFR/DRC
Director

FROM: John Gaudet, AFR/SD/PSGE,
Bureau Environmental Coordinator

SUBJ.: Amendment of the Supplemental Environmental Assessments for Locust/Grasshopper Control to allow African armyworms to be dealt with in East Africa

Recent food-security threatening outbreaks have occurred of the African armyworm in the greater Horn of Africa, engendering numerous inquiries concerning USAID options for intervention, including the potential use of pesticides (summarized in State 184163 and Addis 005391). This office has been asked to determine options for USAID intervention in a manner consistent with its Environmental Procedures ("Reg. 16"), specifically the provisions of the pesticide procedures outlined in 22 CFR 216.3(b)(1).

In view of the fact that the 1994 outbreak in the Horn is well along already, thus will soon have run its course for this growing season, and that pesticide-related assistance cannot be rendered before an appropriate environmental assessment has been conducted, it is unlikely that USAID still will be able to respond this year in a manner which invokes pesticide use, directly or indirectly. Nevertheless, it is desirable that expedited measures be taken to provide for this facility as soon as possible for future armyworm outbreaks.

Two key facts are pertinent in this connection:

1. USAID/AFR's regional AELGA project, established to address short-term and medium-term responses to locust and grasshopper outbreaks, already has a mandate to consider responses to "other emergencies" of a pest-related nature.

2. An overarching environmental assessment concerning locust/grasshopper control operations, the "Programmatic Environmental Assessment for Locust and Grasshopper Control

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Pesticide

in Africa/Asia" (PEA), already provides the context for rational pesticide use, and lays out measures to mitigate potential negative impacts. Over 20 country-specific Supplemental Environmental Assessments (SEAs) have been prepared, including Ethiopia, Eritrea and for the Desert Locust Control Organization of East Africa (DLCO-EA) operations in Somalia (DCLO has a mandate for armyworm control).

The SEAs contain country-specific environmental information and provide guidance on environmentally sound management procedures for pesticide use in a particular country, guidance which to a large extent is directly pertinent to the considerations which would apply in control decisions for armyworms. Given that African armyworms are mass migrating insects with cyclical population dynamics, and will very likely require intervention over a large geographic area to protect vulnerable crops in drought-prone regions in the future, the interventions required are very analogous to those necessitated by locusts. While a definite differentiation needs to be made between control measures for locust/grasshoppers as opposed to armyworms, clearly, there are also distinct benefits and economies to be gained by minimizing the need to re-visit pesticide management, safe use, environmental health and related issues which apply both to armyworm and locust/grasshopper control.

Environmental assessments may be amended whenever a new need arises and/or valuable information that can be utilized in the process of implementing sound programs becomes available and when such information necessitates an update. Thus, four options for dealing with the requirement to prepare an environmental assessment were considered, from more generic to more limited in scope:

1. Design and carry out a new PEA to address the broader array of pest outbreak emergencies in as preventive a way as possible, but with a more limited geographic scope, including at least an updated treatment of locusts and grasshoppers, ass well as rodents and armyworms in sub-Saharan Africa. This option, while desirable in the long-term, would require considerable time and resources, and would not be consistent with an expedited response. Subsequent SEAs would be needed as well.

2. Conduct an amendment to the existing locust/grasshopper PEA to address the specific situation with armyworms in Africa. Then conduct separate country-specific SEA amendments for each country where needed.

3. Carry out separate amendments to the existing Eritrea and Ethiopia SEAs to address the armyworm situation in those countries only. These Amendments would include enough information (e.g., from the PEA and SEAs) to be complete, self-standing documents.

i.e., self-explanatory

4. Delink the armyworm issue from the present PEA and SEAs, and take an independent course following Reg. 16 in connection with a specific planned intervention for armyworms, i.e., do an initial environmental examination, and prepare an independent environmental assessment (which nevertheless will be informed by and based on the PEA and SEAs). This option does not take advantage of economies to be gained by linking the process to the PEA/SEAs.

Determination:

Option 3 is an appropriate and well-circumscribed approach, and consistent with USAID Environmental Procedures and good practice. It will allow immediate steps to be taken to ensure that practical and effective assistance can be rendered if needed, while mitigating and preventing to the fullest extent possible any negative consequences due to pesticide use. The amendments should emphasize, for armyworms even more than for locusts, alternatives to chemical pesticides, as part of an IPM program All the normal considerations which apply to SEAs per se also pertain to the amendments, for example with respect to scoping and coordination with other donors and the host country government(s), the NGO/PVO community and regional pest management organizations such as the DLCO-EA.

Once intervention is imminent in a given country, the amended SEAs should be linked to a Plan of Action developed by the host country government, FAO and/or NGOs as appropriate, before USG assistance in the matter of armyworm is rendered.

Clearance:

GC, STisa_____ Date: 8/5/94
PPC, JHester_____ Date: 8/8/94

Distribution:

AA/AFR/DRCO/AELGA, AShowler
FHR/OFDA
AFR/EA, JPryor
USAID/REDSO/ANR, JFlynn
G/EG/AFS, RHedlund
USAID/Addis Ababa,
USAID/Asmara,

Draft: WIKnausenberger, AFR/SD/PSGE, 1-VIII-94

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APPENDIX 3. FAO Project TCP/ETH/4455(E), Emergency Assistance for armyworm control. Report of consultant Dr. Andrew Harvey. October 5, 1994.

Mary. Yakin

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PROJECT TCP/ETH/4455(E)
EMERGENCY ASSISTANCE FOR ARMYWORM CONTROL.
REPORT OF CONSULTANT

INTRODUCTION

1) The African Armyworm (*Spodoptera exempta*)

The African Armyworm is the larva of noctuid moth. It feeds exclusively on the leaves of graminaceous plants and is a serious pest of cereal crops and pasture grasses. The moth is highly migratory and its life-cycle is adapted to exploit the favourable conditions for larval survival which are created by the movement of the Inter-Tropical Convergence Zone(ITCZ) across the grassland areas of Africa.

The life-cycle is very short, usually about five weeks but sometimes as little as four. The adult moths take off at dusk and fly up to 300 metres above the ground. There they are carried by the prevailing winds until they descend to the ground at dawn and conceal themselves during the day in the vegetation. They will continue to do this nightly until they encounter rain. Over several nights they can be carried hundreds of kilometres. If they fail to encounter rain after about ten nights, they will die without reproducing. However, the prevailing winds tend to carry them into zones of convergence, such as the ITCZ, where there are likely to be convective storms. These storms concentrate the flying moths and the rainfall which they generate stimulates the moths to breed and lay their eggs. When they are ready to mate, the females release a scent, or *pheromone*, which attracts the males. This substance has been analysed and identified. It can now be produced artificially and is used to attract male moths to pheromone traps, which play an important role in forecasting outbreaks.

A female moth may lay two or three egg masses of about 300 eggs each. The total number of eggs produced by a female moth may, in favourable conditions, reach 1000. After two to four days, the eggs hatch and this usually coincides with the flush of vegetation induced by the rainstorm. There are six larval instars, which last a total of about 21 days. In areas where armyworm regularly occur, farmers spot the early instar larvae and are able to carry out control before damage is done to the crop. However, larvae sometimes remain unnoticed until the fourth instar and this seldom leaves time to organise and carry out control before the fifth and sixth instar, during which the most serious damage is done. In practice there can be a period of up to about ten days from the time when larvae are observed until serious damage is done. Control must be carried out within this period if the crop is to be protected.

Major area of conv.

During the last two instars, the larvae frequently exhaust the food supply around where they hatched. If this happens, they march along the ground, usually all in the same direction, seeking fresh food. It is to this behaviour that they owe their common name of "Armyworm". If this occurs in vulnerable crops, the damage is often total. Bands of marching armyworm can also invade crops from neighbouring areas of natural vegetation.

The optimum conditions for larval survival occur at the advancing edge of the ITCZ. They are: the initial flush of new vegetation after the dry season, a high level of insolation, low humidity and an absence of natural enemies. As the rainy season sets in these conditions cease

to exist. The vegetation coarsens, cloud cover increases and natural enemies build up However, their migratory life-cycle enables them to escape these unfavourable conditions

Armyworm are extremely susceptible to attack by a variety of natural enemies, including birds, especially migratory species such as Abdim's Stork (*Ciconia abdimii*). They are also attacked by insect parasites and microbial diseases, including viruses and fungi The birds, understandably, tend to feed on the larvae when they are fully grown and therefore after they have destroyed the crop The migration of the adult moths, as explained above, enables them to escape the build up of other natural enemies High natural larval mortality is therefore seldom observed except when two or more successive generations have taken place in one area

The combination of short life-cycle and high fecundity results in an enormously high potential rate of reproduction Armyworm have been compared to locusts both in their capacity for migration and the devastating damage they can do to crops. They resemble locusts in another aspect of their biology, called "*phase polymorphism*" This is a change, in appearance, behaviour and physiology, which is stimulated by crowding. Armyworm larvae can therefore exist in two forms:

1) *Gregarious*. This is the far[illegible] form of armyworm observed causing damage. The larvae are highly active, gregarious an[illegible]k in colour. It only occurs at high densities.

2) *Solitarious*. The larvae are sluggish and conceal themselves at the bases of the grasses. Their coloration is an inconspicuous brown and green This form only occurs when the larvae are at low density and is seldom seen except by specialists searching for it

The importance of the solitarious phase is that it is in this form that the armyworm survive those months of the year, September through to November, when conditions do not favour the survival of the gregarious form and when, consequently, outbreaks are seldom seen. As far as is known, armyworm survive this period as scattered low density solitarious populations in areas, such as the East African coast, which receive sufficient rainfall in every month of the year to maintain green vegetation. However, the grasses in these areas tend to be coarse and unnutritious and so larval survival is low.

2) Armyworm Migration in Eastern Africa.

The armyworm season in East Africa begins when moths from the scattered solitarious populations that have survived the dry season along the coast migrate inland and encounter the first storms of the rainy season. They are concentrated by the convective winds of the storms and so, when they breed, the first outbreaks of gregarious larvae occur. These are termed "*primary outbreaks*" and their timing and location are among the most important factors determining the subsequent development of outbreaks through the rest of Eastern Africa.

One of the most important primary outbreak areas is around Dodoma and Morogoro in central Tanzania. Primary outbreaks usually occur there in late December at the onset of the rainy season. Moths from them are carried towards the northerly moving ITCZ so that a succession of "*secondary outbreaks*" (outbreaks derived from moths which themselves emerged from previous outbreaks) occurs They normally reach Kenya by March and may continue to Ethiopia and Yemen if conditions are favourable.

3) Forecasting

There is little time between when larvae are observed on the crops and serious damage is done. It is therefore very difficult for farmers, especially small-holders who may be dependent on the extension service, to obtain pesticides and sprayers in time to save the crop. If the extension service is responsible for distributing these materials, it also is likely to have difficulty in doing so in time. If, however, the time available can be lengthened by forecasting the location and timing of the outbreaks, the chances of successful control can be greatly increased. An understanding of the life-cycle and migratory behaviour of the insect makes this possible.

Forecasting depends on three types of information

a The timing and location of the *previous outbreaks*, which tells the forecaster when and from where the moths will emerge. The source of this information will be reports from the extension service.

b *Meteorological data* on the prevailing wind fields, position of convergence zones and occurrence of rainfall enables the forecaster to predict the direction of migration and the location of areas in which conditions conducive to outbreaks will occur. This information can usually be provided by the national meteorological service.

c Catches from *moth traps* tell the forecaster where flying moths are and in what numbers. For this, a network of light and pheromone traps must be established and a reliable system of weekly reporting organised

These data can provide the basis of a weekly forecast which can add about a week to the time available for organising control. If the forecast is immediately available to the extension service, they can initiate the distribution of materials and warn farmers to start searching for young larvae in their crops

4) A Strategy for Armyworm Control.

It must be apparent from what has been said above that successful armyworm control operations cannot be reactive. By the time reports of outbreaks are coming from farmers, the materials required for control must already be in place and the extension agents ready to assist with spraying. To achieve this, there must be a coherent and integrated strategy based on the following three components

a. *Forecasting*. This gives the time for successful action to be initiated
b *Extension*. It is the extension service that will carry out the distribution of materials and assist the farmers with control. They must be trained, equipped and prepared to do this.
c. *Logistics*. Serious outbreaks create a large and sudden demand for materials. This can only be fulfilled by pre-positioning and a planned system of distribution.

Such a strategy can only operate if there are clearly defined responsibilities for all those involved, adequate training and sufficient materials for them to carry out their tasks.

THE 1994 ARMYWORM SEASON IN ETHIOPIA

1) The Development of the Season

damage

The 1994 armyworm season in Ethiopia was the most serious in the experience of crop protection officials. It needs to be understood in the context of the region as a whole. As is so often the case with serious armyworm upsurges, it followed a period of drought and this, of course, will have exacerbated the economic impact of the damage caused.

Tanzania suffered very serious outbreaks in January and February. In March, the infestations spread north into Kenya, continued into April and May. Very unusually, they also invaded the whole of Uganda. The details of these outbreaks are not available to the consultant at present, but their importance in relation to subsequent events in Ethiopia and further north is apparent.

The first outbreaks of the season in Ethiopia were reported from Borena on April 18th. During May, the whole south-east third of the country experienced widespread outbreaks. (Details of outbreaks collected by the consultant are given in Annexe 1)

Some idea of the magnitude and timing of these outbreaks is given by pheromone trap catches. At Asbe Teferi, the pheromone trap caught in excess of 1000 moths every night between 23 and 29 May (maximum catch 1923 moths) and continued to catch more than 100 per night until 7 July. Other traps in that part of the country, such as Hirna, Boke and Darolebu also had peak catches on or around 28 May, but none with such high numbers. (see Annexe 2 for list of trap stations)

During the following week, significant numbers of moths were caught further north and west (Humera 02/06: 261 moths, Kemessie 05/06: 188 moths), anticipating the outbreaks which were reported from 13 June onwards, in both Wello and Tigray.

A subsequent peak of moths appeared in the traps (catches of several hundred in most traps from 24/06 onwards, Kemessie 30/06: 2018 moths) and signalled a further series of outbreaks to be reported in Tigray from 26 June onwards and probably was also responsible for some of the later outbreaks reported in Wello.

Further infestations, covering Tigary and Wello were reported from 27 July onwards. They were probably the offspring of moths from the previous outbreaks breeding locally. Densities were low (<10/square metre) and levels of disease and parasitism significantly high.

2) Control Operations

Control operations can be be divided into three categories.

a. Traditional methods. These included driving cattle over outbreaks, trenching and beating with sticks. These were mainly used on pasture and probably had no more than a marginal effect on larval numbers (although trenching can give effective protection to crops against marching larvae).

b. Ground control. This involved the use of pneumatic knapsack sprayers such as CP15 and some battery-driven ULVA sprayers A wide range of pesticides was used (see Annexe 3)

c. Aerial Spraying This was carried out by aircraft from DLCO-EA and ADMAS (a crop-spraying subsiduary of Ethiopian Airlines). The aircraft were equipped with Micronair ULV sprayers. Fenitrothion 96% technical and malathion 95% ulv were the products principally used.

What about Bacillus thuri?

It is impossible to form an accurate judgement of a control operation that was for all practical purposed over before the beginning of the consultancy However a number of conclusions were drawn from field visits to areas where control had been carried out and discussions with a wide range of people involved.

a. In spite of the problems outlines below, the seriousness of the outbreak left the authorities with little choice but to resort to large-scale aerial spraying

b. Aerial spraying caused serious damage to honey-bees, which are an important source of income for small farmers The economic loss caused by this could run into millions of dollars(see Annexe #).

c. Because of the inaccessibility of some of the areas, aerial spraying was seldom preceded by proper ground surveys. It was normally carried out at the request of the local (warada) administration, a representative of which travelled in the aircraft as a guide and directed the pilot where to spray In the one case that I was able to observe (31/07/94), the guide, a local administrator, had excellent hand-drawn maps from which it was possible to identify the sprayed areas on the 1 250,000 survey sheet. However, when the area (Tserae warada) was visited, there were no dead larvae, frass or signs of crop damage. Local farmers said that the most recent infestation, which had caused little damage to the now well grown crops, had pupated before the spray operation. The major damage had occurred in early July to crops planted in mid- June. In several other places, local farmers said that spraying occurred either after the crop had been damaged or even after the larvae had pupated It should also be added that in other places, it was thought that the aerial spraying had saved the crop

d. The recommended droplet size for armyworm control is 100 microns, but 240 microns was being used during this operation Moreover, although the aircraft were supposed to apply fenitrothion 96% at the recommended application rate of 0 5 litres/ha. calculations by Dr. Samuel (Crop Protection Laboratory) from data provided by the pilots suggested that the actual application rate may have been as high as 1 litre/ha. This is all the more disturbing since experiments carried out by the consultant last year show that 0 25 litres/ha (applied by hand-held ULV) is sufficient to control larvae at all instars, while those of the third instar or younger are killed by 0.125 litres/ha. When it is considered that approximately 30 tons of pesticide were applied during the aerial spraying campaign, these figures assume some significance.

e. The consultant was concerned to discover that fenitrothion 96% was being distributed by the extension service for ground spraying. It should be emphasised

that this is a technical formulation specifically intended for aerial ULV application. Not only is it dangerous to handle without proper protective clothing, which is unlikely to be available, but it was almost certain to have been applied at too high an application rate, as those carrying out the spraying had little awareness of the differences between the various products available to them. If the 96% technical is the only pesticide available for ground ULV application, it should be diluted with diesel to no more than 50% (25% would probably be better), before being distributed.

3) Damage.

Estimating damage caused by armyworm outbreaks is notoriously difficult. Because outbreaks are extremely patchy, there is a tendency to overestimate ~~the~~ both the area infested and the density of larvae. Moreover, the degree of defoliation caused by a a given density of larvae will vary enormously with the stage of development of the crop and the yield loss caused by that degree of defoliation will vary with the growing conditions during the recovery period. In the current outbreak, not even figures of total destruction can be accepted without reservation, because poor rains retarded the crop in the early growing period and farmers were often not able to say whether their decision to replough and plant again was due to the effects of drought, armyworm or a combination of the two. However, in Tigray, 2500 ha were reported to have been reploughed as a consequence of armyworm attack. Since reports were still coming in, the final figure is likely to be much higher. The cost of such a loss is estimated at $230/ha. (see Annexe 5) and so the loss of 2500 ha would be worth $575,000

However, the areas totally destroyed were a small proportion of those infested. Form the figures available (Annexe 1), it appears that most crop infestations received control. Untreated areas which only suffered partial damage will probably yield less, but, for the reasons outlined above, it is impossible to assess how great that loss is likely to be.

ARMYWORM CONTROL STRATEGY FOR ETHIOPIA

As was explained in the introduction, effective armyworm control can only be achieved by a coherent national strategy based on forecasting, extension and logistics. The consultant was therefore concerned to find out to what extent the elements of such a strategy already existed in the country and how best they could be integrated together. [illegible]

1) The Trap Network.

A network of pheromone traps was established in Ethiopia some years ago in co-operation with the DLCO-EA Regional Armyworm Project, based in Nairobi. Many of these traps are still running and indeed provided valuable information on the development of the upsurge. However, if the network is to provide the basis of an effective control system, it needs to be strengthened in a number of ways.

a. The network should be expanded to about 100 stations to give adequate coverage of the whole country. One way of finding suitable sites in the more remote and non-agricultural parts of the country would be to request the co-operation of the National Meteorological Service in siting traps at Met. stations. There are about 40 Met. stations with full time observers and these report daily by radio. Some of these could provide an invaluable addition to the existing network.

b. Although operating a pheromone trap is a comparatively simple task, it is important that it is carried out correctly and conscientiously. A brief training course, in which the purpose of the trap network is explained and operating and reporting procedures thoroughly taught, can make a very great difference to the efficiency of the forecasting system. A simple booklet for operators to supplement the course is also needed.

2) Meteorological Data.

The consultant visited the National Meteorological Service to investigate the possibilities of co-operation with the Crop Protection Laboratory in the forecasting of armyworm and other migratory pests. He met Ato Siyoum Yami (Forecasting) and Ato Tufa Dinku (Satellite Data Reception & Processing).

The Met. Service has in the past co-operated with DLCO-EA in locust forecasting, assigning an officer to provide daily briefings. It would be able to provide stream-line maps at a variety of levels to predict moth migration. Ato Siyoum emphasised that the effect of topography on wind-fields in Ethiopia is very pronounced and it was therefore necessary for an experienced meteorologist to be closely involved in the interpretation of the data.

The Met. Service is equipped with a Meteosat receiver which not only provides real time images of cloud, but also gives access through MMD to a wide range of weather data and analytical models. The most important of these would probably be ECMWF, which gives wind speed & direction at 5 deg resolution. It is transmitted in digital form. A similar product is RJP, which shows the frontal systems particularly well, but this comes as a fax and so would be difficult to transfer to a GIS (see below).

Imaging data is processed by AUTOSAT 3 (University of Bradford). At present, dekadal Cold Cloud Duration (CCD) and estimated rainfall images are produced and archived. The image most useful for armyworm forecasting is the 1800-0600 hrs 12 hour CCD. The system could capture this image, but it would put a strain on their computer time. It would probably be necessary to provide an extra PC dedicated to this task.

Ideally, these images and, indeed other met. data, should be passed in the format of a suitable Geographical Information System (GIS) directly by modem to the computer at Crop Protection Laboratory. The Met. Service at present uses three different GIS's, ILWIS, IDA and IDRISI. ILWIS is probably too complicated a system for this task, but either IDA or IDRISI would be suitable and could be installed at Crop Protection Laboratory, where it would also be useful for other aspects of the division's work.

Some development work needs to be done on these systems. For example the Meteosat images would need to be "resampled" (i.e. changed) to a standard projection. However, the consultant is at present involved in a co-operative programme between Inter-national Red Locust Control Organisation for Central and Southern Africa (IRLCO-CSA) and the Zambia Dept. of Meteorology, who have the same Meteosat receiving system, to produce something very similar. If this exercise is successful, the results could probably be transferred to Ethiopia.

3) Reporting Outbreaks

The extension service, which employs field agents at the level of peasant associations, produces very full reports on all aspects of their work and factors relating to agriculture However, from the point of view of practical armyworm forecasting and management of control operations, the reporting system is too inconsistent, slow and seldom provides the necessary information. Furthermore, the development agents have not been trained to make proper reports of outbreaks For example, densities of larvae are exaggerated because counts are not at random. To rectify this, the following changes need to be made

a. The reporting system must be *standardised*. The same information about outbreaks must be collected and recorded in the same format throughout the country.

b. It must also be *simplified* The consultant saw reports which contained such information as the number of cattle that had been employed in trampling armyworm to death.

c. Extension agents must be *trained* to make armyworm reports

The solution to this lies in the production of a standard armyworm report form, which needs to be no bigger than a postcard This can record the date and place of the observation, the crops affected and their stage of development, size of larvae at the time of observation, larval counts to determine density and control operations in hand These cards should be in Amharic and issued in advance to the extension agents, who should complete them on the spot if outbreaks are observed. They can then be passed to the zonal office for action Standard summary forms should be used by zonal and regional offices for recording reports and the original cards should be forwarded to the Crop Protection Laboratory

4) Armyworm Database

During the DLCO-EA Regional Armyworm Project, a computerised database for moth trap catches and outbreaks was developed for use in Kenya and Tanzania This is an extremely valuable tool to the forecaster, because it presents a mass of complex information to him in simple graphical or tabular form and also enables comparisons to be made with previous seasons, provided the historical data has been entered. The program is written in the dBaseIV language.

The consultant has, while working with IRLCO-CSA, been able to adapt the program for use in other countries, although not all features are available in the modified version. A copy of this, configured for Ethiopia, has therefore been installed on a computer at the Crop Protection Laboratory and all available trap and outbreak data is being entered on it

It should be emphasised that this installation is provisional. It provides an opportunity to train Crop Protection staff in the use of the program and to begin the task of entering historical data and so building up a national database. A definitive installation will need a fully modified version and a PC dedicated to its use

FAO is at present employing a consultant to produce a complete adaptation of the program to be usable in any country. This version will soon be available and should replace the one installed by this consultant.

A good deal of the historical trap data for Ethiopia is held by DLCO-EA at the Nairobi station. This should be brought back to Addis Ababa and entered into the database.

4) Control

By far the most preferable way of controlling outbreaks is by ground spraying carried out by extension agents, or farmers with their help and supervision. In this way, spraying is likely to be concentrated on outbreaks that pose a real threat to crop production.

The existing extension system, with specialists at regional and zonal levels, extension supervisors at warada level and agents at the level of peasant associations, is well adapted to do this. However, if control is to be carried out effectively and safely, adequate training and protective equipment must be provided.

Pneumatic knapsack sprayers are widely available, but where these are inadequate to the task, hand-held, battery-driven ULVA sprayers (one ULVA sprayer can treat 5 ha/hour) can be used. The logistics of using ULVA's are also relatively easy. A team of 5, working for four hours could treat 100 ha and would use about 50 litres of pesticide. Such teams with their materials could reach remote villages using animal transport if necessary. An extension agent could even carry two or three sprayers and 20 litres of pesticide on the back of a motor-cycle.

5) Extension Training

Training extension agents in identification, reporting and control of armyworm outbreaks should be the responsibility of zonal crop protection specialists. For this they will need some training themselves and also suitable materials such as booklets and flip-charts.

It should also be noted that the Crop Protection has a number of Plant Health Clinics around the country, whose specialist staff would normally include an entomologist. They should provide a useful source of assistance and training to the extension service in the areas they serve.

6) Logistics.

It is probably here that the shortcomings of the present system are greatest. It is essential that emergency stocks of pesticide and other materials (sprayers, batteries and protective equipment) are held at strategic positions in the country. These stocks need to be kept in properly designed and constructed pesticide stores, where they cannot constitute a danger to people and the environment.

The store managers need to be trained in the safe handling of pesticides, the maintainence of application equipment and protective clothing and the correct use of the chemicals under their charge. There must be a system of management that ensures that stocks do not deteriorate through poor or overlong storage and that products are only used for the purposes for which they are suitable.

The stores must be equipped to repack and label pesticides for distribution in small quantities when necessary They must be designed to contain any accidental spillage and have evaporation tanks (oil and water) to prevent contaminated waste entering ground-water supplies. There must be emergency showers and fire-fighting equipment.

7) Regional Forecasting.

Although an effective armyworm control strategy requires a national forecasting unit, exchange of information between countries plays an important part in anticipating serious upsurges This is particularly true of Ethiopia, since moths migrate into the country from outbreaks further south.

A regional armyworm forecasting system was developed in DLCO-EA during the Regional Armyworm Project. Its effectiveness has tended to be hampered by difficulties in communication between it and the national plant protection services. If, however, all countries in the region come to use a common computerised database (i e. WormBase) the possibility exists of exchanging data through an e-mail conference area.

If the national forecasters also used a common GIS, met data such as CCD data at a quarter-degree square resolution, could also be distributed by e-mail in the form of ASCII values files of a manageable size.

CONCLUSIONS

1) The scale of the 1994 armyworm upsurge was highly exceptional, but armyworm are a regular problem in Ethiopia, as are other migratory pests. Provision must be made to deal with them, since a reactive strategy will be both ineffective and more costly.

2) Whatever the shortcomings of the control campaign, it must have saved many thousands of hectares. The loss would not have been only a simple financial one, but must be estimated at the cost of replacing lost production with food relief. One must also take into account the long term effect on rural development of the loss of morale in farmers whose crops would otherwise have been destroyed in the first good growing season after a serious drought.

3) However, if a future emergency of this sort is to be met effectively, economically and with minimal environmental damage, a coherent national strategy must be developed and this probably applies equally to other pest emergencies Assistance will be required in bringing this about.

RECOMMENDATIONS

The consultant recommends the development of a national strategy for armyworm control based on forecasting, extension training and pre-positioning of strategic stocks of insecticide and sprayers. Donor support should be sought for those components that do not already exist in the country.

1) National Forecasting Service.

An armyworm forecasting unit needs to be established within the Crop Protection Division at its laboratories at Sholla, Addis Ababa

The unit should be equipped with a computer on which the armyworm database program, WormBase, and a suitable Geographic Information System (GIS) such as IDA or IDRISI would be installed.

The network of light and pheromone traps needs to be revived and expanded Trap operators need to be trained.

The co-operation of the National Meteorological Service should be sought in providing the necessary weather data and remote sensing products. If necessary, the Met. Service should be provided with a computer that can be dedicated to providing remote sensing data for migratory pest forecasting to both the national Crop Protection Division and DLCO-EA

Yes! A standard system of reporting armyworm outbreaks using post-card sized forms should be introduced to the extension service

There should be close co-operation between the national armyworm forecasting unit and that of DLCO-EA in order that information on outbreaks and trap catches in neighbouring countries should be available to assist in forecasting. The DLCO-EA regional forecasting unit should be strengthened as a means of exchanging information between countries in the region.

2) Extension Training.

A one week training course should be held for regional and zonal crop production and protection specialists to cover the following points

a. the importance of armyworm forecasting in ensuring effective control of outbreaks.
b. the role of the regional and zonal agricultural offices in executing promptly a pre-planned response to armyworm forecasts,
c. the training that needs to be given to extension agents in identification, reporting and control of armyworm outbreaks,
Env. d. the correct and safe application methods for pesticides used in armyworm control

Booklets and other training materials should be prepared to assist regional and zonal specialists in training extension agents.

3) Logistics.

ENV Strategic stocks of pesticides for migratory pest control should be held by the Ministry of Agriculture in purpose-built stores designed and equipped to ensure that they do not constitute an environmental hazard and that materials are stored in conditions that minimise their deterioration.

There should be a main intake store with a capacity of 150 tons and a number of supplementary stores, with a capacity of 50 tons, sited in parts of the country most likely to require control of migratory pests.

The stores should be equipped to clean, maintain and hold the Ministry's stock of spray equipment.

The store managers should be trained in the safe handling and storage of pesticides.

Plans for the distribution of pesticides and sprayers to zonal or warada level should be made in advance and put into effect when outbreaks are forecast for the area.

Donor support should be sought for the construction of such stores and the training of their staff.

Donor support should also be sought to maintain a strategic stock of pesticide

4) Aerial Spraying Operations.

Aerial spraying should not be the preferred method of controlling armyworm outbreaks, but there may be circumstances, as during the present season, when it is clear that ground spraying cannot be carried out fast enough on the scale required to prevent extensive crop loss. Aerial spraying may also be necessary for other pest emergencies.

ENV Clear criteria should be laid down for the conditions under which an aerial spray sortie is to be regarded as necessary and safe. These should include:

a. a ground survey by specialist staff to determine the need for the operation,
b. absence of human dwellings,
c. appropriate safe-guards for honey-bees.

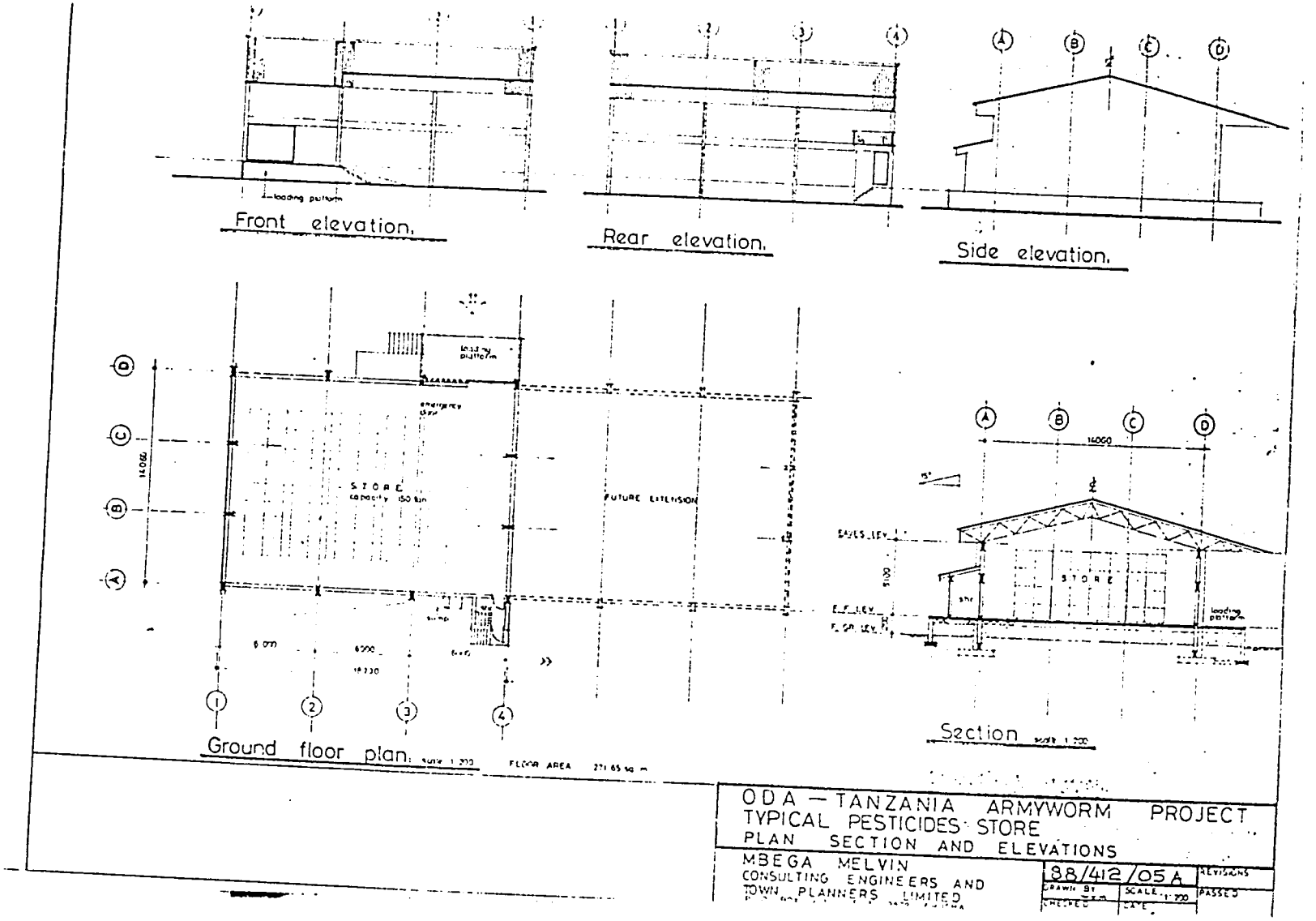
An aerial spraying operation should be under the direct control of the Crop Protection Division. At least two staff members should receive three months training overseas in the management of aerial spraying operations. ?

5) Pesticide Application Rates.

Trials should be carried out, using all the currently available types of spray equipment, to determine the minimum application rates necessary to give adequate control, of those pesticides most commonly used against armyworm,.

ITINERARY

23/07/94	Ndola	London
24/07/94	London	Rome
25/07/94	Rome	Athens
26/07/94	Athens	Addis Ababa
29/07/94	Addis	Dese
30/07/94	Dese	Mekele
02/08/94	Mekele	Aksum
04/08/94	Aksum	Adi Agrat
05/08/94	Adi Agrat	Mekele
07/08/94	Mekele	Maychew
08/08/94	Maychew	Woldiya
09/08/94	Woldiya	Robit
10/08/94	Robit	Addis Ababa
27/08/94	Addis Ababa	Sana'a
***** TCP/YEM/4452*****		
25/09/94	Sana'a	Addis Ababa
05/10/94	Addis Ababa	Rome



BEST AVAILABLE DOCUMENT

APPENDIX 4. Armyworm control operations in Ethiopia during 1994 crop season. Crop Protection Division, Agricultural Development & Crop Protection Department, Ministry of Agriculture; Addis Ababa. October 1994.

ARMYWORM CONTROL OPERATIONS IN ETHIOPIA DURING 1994 CROP SEASON

CROP PROTECTION DIVISION
AGRICULTURAL DEVELOPMENT
& CROP PROTECTION DEPARTMENT
MINISTRY OF AGRICULTURE
ADDIS ABABA

OCTOBER, 1994

1. Introduction

The African armyworm, Spodoptera exempta is one of the most destructive insect pests in the country. It causes considerable damage to rangeland grasses and cultivated crops such as maize, sorghum, wheat, barley, millet and tef (Eragrostis tef). The extent of damage caused by army worm depends on the growth stage of the crop attacked and rainfall situation following attack. If the crop is attacked at the early stage of development, total crop loss may occur. If the crop is attacked at the latter stage of growth, the plant can recover fully or partially depending on rainfall situation.

Primary outbreaks in eastern Africa usually start in Central Tanzania sometimes in December. From there successive generations of adult moths fly northwards with the prevailing winds arriving in Kenya around February and reaching southern Ethiopia in April or May. Otbreaks may continue until July or August in Central Ethiopia and sometimes as late as September or October in northern Ethiopia. Recent outbreaks also indicate that primary outbreaks may originate in southern Ethiopia when the environmental condition is favourable.

2. The 1994 Armyworm Situation

The 1994 armyworm outbreak was considered to be the worst in several years, probably due to heavy rainfall which occurred after a prolonged dry spell period. The first outbreak was reported in Borena zone in southern Ethiopia on 18 April 1994. Then the outbreak spread to the eastern Ethiopia. By the end of May the outbreak spread throughout the country with the exception of Afar region.

The number of zones and woredas affected were 42 and 406 respectively. In these areas the total land area affected was 1,267,451 ha. Of these, 882,419 ha were crop land and the rest pasture land (Table 1). The crops affected were mainly maize, sorghum and millet. Infestations on tef, wheat and barley were relatively less common since these were not planted in many areas at the time of the outbreak due to a delay on the onset of the long rain, particularly in the eastern and north eastern parts of the country.

Armyworm trap catches also indicate the seriousness of the 1994 armyworm infestations. For example, in Asbe Teferi, the pheromone traps caught more than 1,000 moths every night between 23 and 29 May. Similarly, in Enda Selassie pheromone traps caught in excess of 600 moths between 4 and 7 June. Pheromone trap catches in Enda Selassie also started increasing from 21 June on wards until it reached its peak of 767 on 26 June 1994. This may probably indicate the arrival of new batches of moths to the locality.

Very serious infestations of African armyworm were also reported in many countries in Africa and in Yemen. Tanzania, Kenya, Uganda and Chad reported serious outbreaks. Damage caused by armyworm was reported exceptionally very serious in

Yemen where no control measure was undertaken due to internal conflict between South and North Yemen.

Table 1: Summary of army worm outbreaks in different regions

No	Region	Zone	Wereda	PAs No	Date 1st observed	Attacked crops	Affected Area (HA)	
							Crop	Pasture
1	Tigray	4	67	-	27/5/94	S,M,Mi	151,320	120,218
2	Three	7	103	1639	-	M,S,Mi, B,W	258,142	181,137
3	Oromya	12	181	2438	18/4/94	S,M	321,132	82,802
4	Southern EPA	13	37	826	6/5/94	S,M	72,905	-
5	5	1	3	25	9/5/94	S,M	43,740	-
6	6	2	8	-	-	S,M	20,055	-
7	12	1	3	-	-	S,M,Mi, T	136	-
8	13	1	1	17	11/5/94	S,M	10,225	875
9	14	1	2	-	-	S,G	41	-
10	Dire Dawa	Na	1	-	-	S,M	4,723	-
	Total	42	406	4945			882,419	385,032

Note

S = Sorghum
M = Maize
Mi = Millet
B = Barley
W = Wheat
T = Tef
G = Grass

2. Control Operations

Extensive control operations were undertaken in all outbreak areas using chemicals and traditional methods such as driving cattle over outbreaks, trenching and beating with sticks. Chemical control were mainly undertaken on crop lands while traditional methods on grasslands although this was not observed strictly in some localities.

Chemical control both by air and ground were undertaken on 366,414 ha (Table 2). Of these about 95,000 ha or 25.9% of the infested area were treated by air. Except for 3,600 ha treated in the eastern Hararghe zone, all aerial control operation were conducted in the Tigray region. Aerial spraying were carried out using DLCO-EA and Ethiopian airlines spraying aircrafts. Only 5.4% of the treated area was grassland.

A total quantity of pesticides applied both by air and ground were 275,391 lt and 60,331 kg. The pesticides mainly used for aerial control were fenitrothion 95% ULV and malathion 95% ULV, but for ground control different types and formulations were used.

Traditional control measures were widely practiced in the Tigray region. The total infested area treated by traditional methods in region was over 11,553 ha. The total number of persons and cattle population that participated in the traditional method of control were 263,596 and 244,888 respectively. This is truly a good example of peoples participation in the control of pest outbreaks.

Table 2: Summary of army worm control and damage

No	Region	Treated Area (Ha)		Pesticides Applied			
		Crop	Pasture	Lt	Kg	Area Damaged (Ha)	Area Replanted (Ha)
1	Tigray	131,228	11,553	79,184	8,499	2,005	2,005
2	Three	53,282	1,850	46,990	14,581	16,177	11,118
3	Oromya	108,645	5,357	104,451	23,024	130,330	96,875
4	South-ern EPA	26,209	-	22,261	10,420	-	-
5	5	12,840	-	12,650	-	10,000	10,000
6	6	4,773	-	4,348	1,325	-	-
7	12	51	-	90	7	-	-
8	13	1,902	100	1,320	575	1,159	1,159
9	14	0.5	-	2	-	-	-
10	Dire Dawa	4,723	-	4,095	1,900	-	-
	Total	347,653.5	18,760	275,391	60,331	159,671	121,157

4. Crop Damage

Losses caused by the African army worm is very difficult to estimate. For one reason the extent of damage caused by armyworm varies depending on the stage of the crop attacked, the extent of damage and rainfall situation following attack. If the extent of damage is slight and rainfall is sufficient, crop loss is not significant. On the other hand, if the crop damage is heavy and rainfall is not sufficient crop losses would be significant. In light of such complex interrelationships it is very difficult to estimate the actual yield reductions caused by this year's armyworm outbreaks. If it is not more difficult, it is equally difficult to estimate the extent of damage caused on grassland.

In the current outbreak, the only loss figure available is total crop land that was destroyed in the various regions. Although all the regions have not reported the total land area destroyed by army worm, reports that have come from five regions namely Tigray, Region Three, Oromya, Region Five and Region Threteen indicate 159,671 ha were completely destroyed by armyworm (Table 2). Out of this 121,157 ha or 75.9% of total hectarage that were destroyed were replanted with early maturing crops. In this case, the additional cost that was incurred was the cost of seed, fertilizers and labour. these costs are again difficult to estimate since there is no information regarding how many of the farmers have used improved seeds and/or fertilizers.

The total crop land that was totally destroyed and not replanted were reported to be in the Oromya and Region three and their hectarage were reported to be 38,514. If the average yield is assumed to be 10 quintals per ha, the total yield reduction would be 385,140 quintals. Again if the cost of a quintal of grain is assumed to be Birr 75 the total monetary loss would be Birr 28,885,500. Various governmental and non-governmental organizations have participated in providing resource - poor farmers with re-planting seeds.

5. Distribution of Crop Protection Materials

When the occurrence of armyworm in the negihbouring countries were reported to the Ministry, an immediate action was taken in the distribution of insecticides, sprayers and other necessary crop protection materials to all zones that could be threatened by armyworm infestations (Table 3).

5.1 Insecticides

Over 295,626 lts and 96,635 kgs of various types of insecticides have been distributed to the regions before and during armyworm outbreak period. The type and quantity of insecticides distributed are listed below:

Chlorpyriphos 24% ULV	-	2,200 lts
" 40% EC	-	25,200 "
" 45% EC	-	6,000 "
Fenitrothion 50% EC	-	39,200 "
" 95% ULV	-	75,400 "
Malathion 50% EC	-	58,528 "
" 95% ULV	-	37,600 "
Diazinon 60% EC	-	9,398 "
" 100% ULV	-	1,200 "
Cypermethrin 10% EC	-	13,400 "
Dichlorovos 50% EC	-	13,200 "
Carbosulfan 25% EC	-	7,600 "
Nurele 2.5%	-	1,200 "
Karate 4% EC	-	6,500 "
Total		296,626 lts

Carbaryl 85% WP	-	83,375 kgs
Trichlorphone 80% WP	-	13,260 "
Total		96,635 kgs

Out of the total quantity distributed 48,200 lts and 4,050 kgs of various types of insecticides were air lifted to Tigray Region.

5.2 Sprayers and Dry Cell Batteries

This is probably a record number ever distributed in a single year. Out of this 6,480 pices were locally procured from AISCO for the operation of ULVA sparayers. The Ministry also locally procured 50,000 pieces of dry cell batteries and distributed to the regions. In addition sprayer maintenance technician was despatched to the regions to undertake repair work.

5.3 Protective Materials

To ensure the safe usage of pesticides, the Ministry distributed 4,590 pieces of protective materials which include overalls, gloves, goggles, face masks and boots.

5.4 Av - gas and Jet A1

For DLCO-EA spraying aircraft 4,800 lts of AV - gas was airlifted to Shire and Mekele in addition to 1,200 lts sent by road transport. Similarly 11,600 lts of Jet A1 were air lifted to Mekele since there was shortage of Jet A1.

5.5 Others

The Ministry of Agriculture despatched over 1.1 million Birr to the various regions to cover miscellaneous expenses such as per diem, oil and fuel, etc. This is in addition to the expenses incurred by Ministry of Agriculture regional, zonal and woreda offices.

Table 3: Crop protection materials distributed to the regions during 1994 crop season

Region	Insecticides		Sprayers (Pcs)	Protective materials (Pcs)	Dry cell battery (Pcs)
	Lts	Kgs			
Tigray	100,000	14,800	987	240	7,800
Region 2	1,000	-	24	51	200
Region 3	43,500	11,500	1,702	856	11,800
Oromya	79,500	33,660	2,273	1,438	14,076
Dire Dawa	8,600	500	13	25	2,600
Region 5	17,798	4,000	420	160	9,200
Region 6	6,400	3,025	388	59	2,200
Southern Ethiopia PA	35,428	28,150	1,915	1,721	8,600
Region 12	3,000	-	100	-	-
Region 13	1,400	1,000	20	40	-
Total	296,626	96,635	7,842	4,590	56,476

6. Assistance obtained

Based on the request made by the Ministry of Agriculture, various assistance had been obtained through FAO and United Nations Emergency Unit for Ethiopia (UN - EUE). The assistance obtained from the various donors include the following:

6.1 The Swiss Government donated USD 38,000 for hiring spraying air craft from Spray Service Unit of Ethiopian Airlines.

6.2 The Government of Norway donated USD 6,500 to airlift pesticides to Tigray Region.

6.3 The Government of Netherlands also donated USD 8,234 to airlift pesticides and other crop protection inputs to Tigray Region.

6.4 SIDA donated one million Birr for the purchase of 32,800 lt of pesticides locally from AISCO. In addition, SIDA provided USD 50,000 through DLCO-EA for hiring spraying air craft from Spray Service Unit of Ethiopian Airlines.

6.5 Through UN - EUE, UNDP provided USD 50,000 for hiring the services of migratory pest consultant and for extending the contract for the Spray Service Unit of Ethiopian Airlines.

6.6 FAO through TCP/ETH/4454(E) donated USD 250,000 for the purchase of the following materials and services:

International consultant	$ 24,000
Technical backstopping	6,000
Official travel	5,000
General operating expenses	5,000
Pesticides	140,000
Sprayers	32,000
Protective clothing	8,000
Communications equipment	10,000
Direct operating expenses	20,000
Total	250,000

6.7 DLCO-EA contributions included the following:-

- 6 Land Rovers fitted with ENS
- One lorry load of 10 drums of AV gas and 5 drums of insecticides for Region Three
- One Land Rover to Mekele and other northern areas for survey and control operations
- One air craft for the control of armyworm in Eastern hararghe, Dire Dawa and Tigray Region
- One lorry load of 10 drums of AV - gas and 10 drums of insecticides to Mekele
- One lorry load of 10 drums of AV gas and insecticides for Humera

6.8 The Government using funds obtained from donor communities obtained pesticides and equipment from the following sources:

- 49,800 lt of pesticides donated by the Japanese Government under KR2 1992 and 88,600 lts of pesticides donated by the Japanese Government under KR2 1993
- 38,800 lt/kg of pesticides donated by the Republic of Korea
- 719 knapsack sprayers procured from ERRP

7. Problems

A number of problems were encountered during the 1994 army worm infestations, and the major ones are stated as follows:

7.1 There had been shortage of insecticides and sprayers in some outbreak areas to match the scale of infestations. As a result the impact of the pest was severe in these areas.

7.2 Shortage of vehicles for surveying and control operations was the most serious problem in all outbreak areas.

7.3 Inaccessibility of some of the outbreak areas, particularly during the rainy season affected the distribution of pesticides and sprayers.

7.4 Lack of timely reporting of outbreaks in some areas did not enable to undertake control operations prior to crop damage.

7.5 Despite the efforts made by the Head Quarters in issuing early warming to those regions which were likely to face unprecedented infestations, the response was however inadequate interms of organizing the available resources for immediate action.

7.6 Lack of pheromone traps in some potential agricultural areas limited early detection of the larvae.

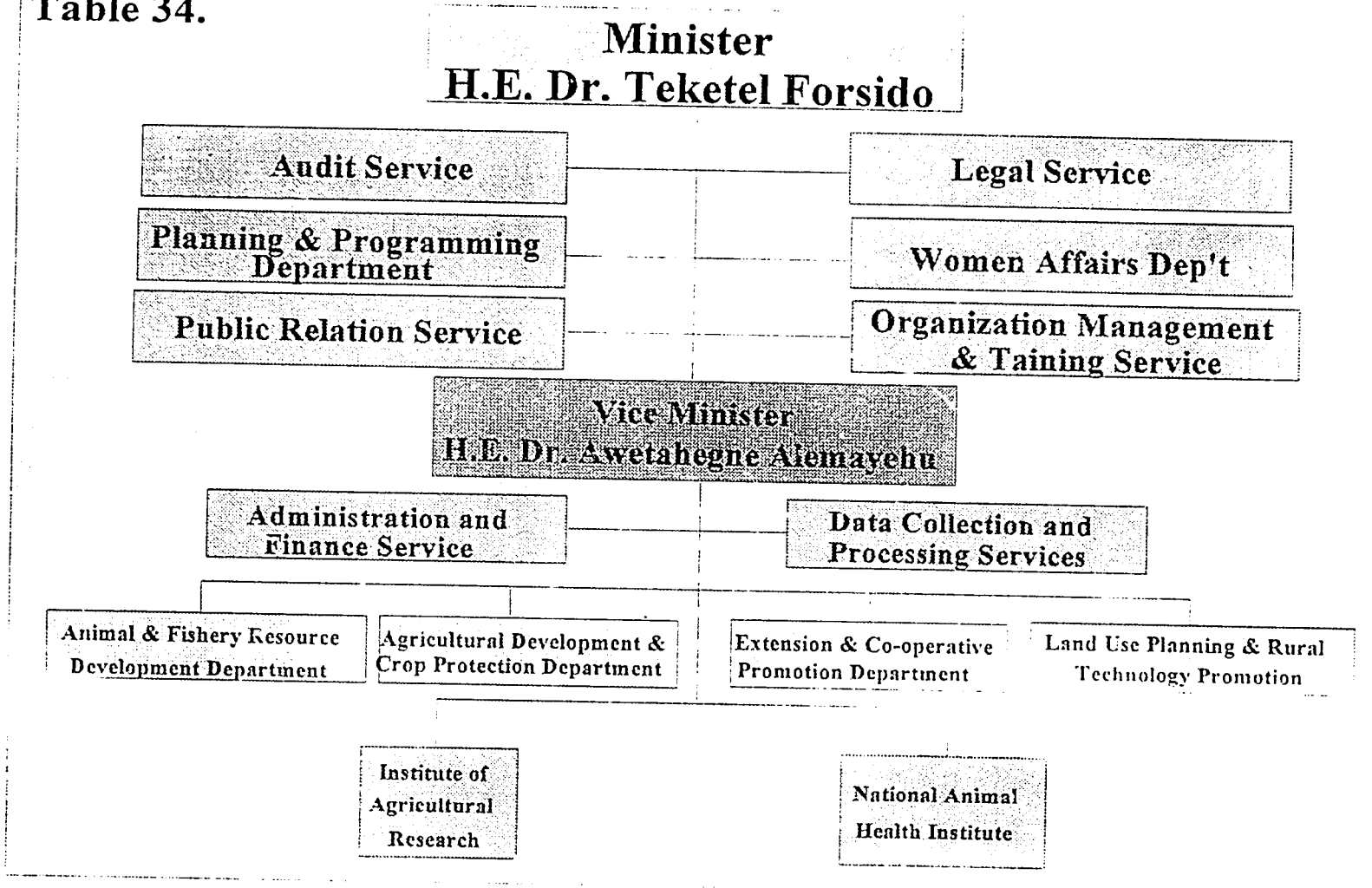
7.7 Lack of man power in some of the newly opened woredas prevented conducting an effective control operations.

7.8 Extensive aerial control operations undertaken in the Tigray Region caused serious damage to honey - bees.

7.9 Lack of suitable pesticide formulations for aerial spraying in the country, forced the Ministry to urgently bring ULV formulation to Addis Ababa from Djibouti sea port and then air lift to the operation area.

APPENDIX 5. Structure of the Ethiopian Ministry of Agriculture as of November 1994.

Table 34.


Minister
H.E. Dr. Teketel Forsido
Audit Service
Legal Service
Planning & Programming Department
Women Affairs Dep't
Public Relation Service
Organization Management & Taining Service
Vice Minister
H.E. Dr. Awetahegne Alemayehu
Administration and Finance Service
Data Collection and Processing Services
Animal & Fishery Resource Development Department
Agricultural Development & Crop Protection Department
Extension & Co-operative Promotion Department
Land Use Planning & Rural Technology Promotion
Institute of Agricultural Research
National Animal Health Institute

APPENDIX 6. Map of National / Regional self government units.

10 Regions
59 Zones
[illegible] Woredas

NATIONAL / REGIONAL SELF GOVERNMENT UNITS

Tigray Region (Reg. 1)

1.
2.

Afar Region (Reg. 2)

1. Assab Zone
2. North Hararghe Zone

Amhara Region (Reg. 3)

1. North Gondar Zone
2. South " "
3. North Welo Zone
4. South " "
5. East Gojam Zone
6. West " "
7. North Shewa Zone

Somali Region (Reg. 5)

1. North Dire Dava Zone
2. East Hararghe Zone
3. Ogaden Zone
4. East Borena Zone

Benishangul Region (Reg. 6)

1. Metekel Zone
2. Asoca Zone

Southern Region (Reg. 10)

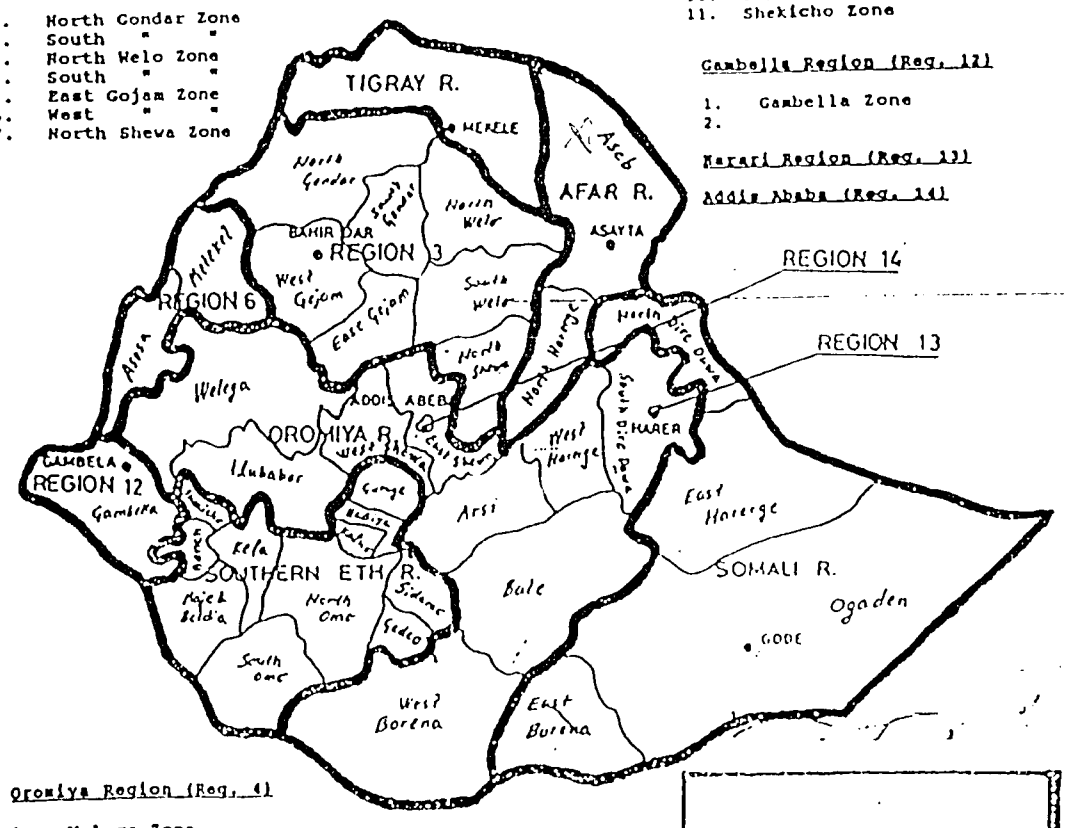
1. Gurage Zone
2. Hadiya Zone
3. Kaficho Zone
4. Sidamo Zone
5. Gedeo Zone
6. North Omo Zone
7. South " "
8. Kefa Zone
9. Maje & Boldiga Zone
10. Bench Zone
11. Shekicho Zone

Gambella Region (Reg. 12)

1. Gambella Zone
2.

Harari Region (Reg. 13)

Addis Ababa (Reg. 14)



Oromiya Region (Reg. 4)

1. Welega Zone
2. Ilubabore Zone
3. West Shewa Zone
4. East " "
5. Arsi Zone
6. West Hararghe Zone
7. Sough Dire Dava Zone
8. Bale Zone
9. West Borena Zone

LEGEND

INTERNATIONAL BOUNDARY
REGION BOUNDARY
REGION CAPITAL
ZONAL BOUNDARY

APPENDIX 7. Minutes of the Army Worm FAO Steering Committee Meeting. July 12, 1994.

联合国粮食及农业组织
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION
منظمة الأغذية والزراعة للأمم المتحدة

THE OFFICE OF THE REPRESENTATIVE IN ETHIOPIA
P.O. BOX 5536 FAX. 51-52-66 TEL. 51-72-33

FAOA - 1070/94
DL/17/2

20,July 1994

Dear Sir,

I am pleased to invite you to a meeting of Armyworm Steering Committee meeting to be held on Friday 22 July 1994 at 2:30 P.M at FAOR office. The meeting will be chaired by Mr. N.A Van Der Graff, chief, Plant Production and Protection Division in, FAO Head-quarters.

Agenda:

1. Current Armyworm situation.

2. Donor pledges.

Attached please find the minute of Armyworm Steering Committee meeting held on 12 July 1994.

Confirmation of your attendance is highly appreciated.

Sincerely yours

Marjorie Smith-John
Acting FAO Representative in Ethiopia

Pesticide donation information, but nothing on registration or disposal.

Minute of Army Worm Committee Meeting

Date : 12 July 1994.

Place: UNDP Conference room

Agenda:-

1. Current Armyworm situation. - MOA/DLCO/UNDP-EUE
2. Utilization of fund - UNDP/EUE
3. Requirements for control of Armyworm -MOA/UNDP-EUE
4. Current status of Donor Pledges.

Agenda Item one

Armyworm Situation and Control Measures Taken

- The fist armyworm outbreak in Ethiopia started in Borena Zone Teltele Wereda on 18 April 1994 followed by further outbreak in Eastern Hararge and Bale Zones in early May 1994.

- The armyworm infestation simultaneously covered many parts of the country, except in Afar Region and few highland areas. The armyworm outbreak this year is the worst recorded in many years. According to MOA report, as of 10 July 1994, areas affected including pasture and cropland, were in the order of 869,000 hectares. Control measures taken on cropland areas amounted to 181,000 hectares using 158,563 lit and 35,900 kg of various pesticides. Of this, 4,200 hectares in Eastern Hararge Zone and Dire Dawa were sprayed by DLCO -EA aircraft and 16,600 hectares in Tigray Region by DLCO-EA and Admas Air.

- At present severe armyworm infestation is observed in the Northern regions of Ethiopia mainly in Tigray, Region. In Tigray the first generation of armyworm started on 30 May, 1994 covering 75,000 hectares, of which 50% were on the croplands. The second generation infestation started on 30 June 1994 covering a total of 35,000 hectare of croplands and 17,000 hectares of pasture lands. The level of infestation is still increasing and there is the likely hood that there will be second generation outbreak of Armyworm.

-The aerial operation is going on in Shire and Axum beginning, 28th June using DLCO-EA aircraft and Admas Air hired from Swiss Government contribution. Aerial and Ground control operation is going on in Tigray Region.

Agenda Item Two

Utilization of Funds

(a) UNDP/EUE

- The funds secured through UNDP/EUE for armyworm control operation from donor agencies amounted to 102,734 usd i.e

Swiss Government 38,000USD
Netherlands 8,234
Norway 6,500
UNDP 50,000

Pesticides

The funds were utilized as follows:

-Hiring of Admas Air for 20 flying hours for armyworm control operation in Tigray Region.

-Transport cost of private trucks which loaded 3,400 liters of ULV, 3,100 Kg of carbaryl as well as 6,400 lit of malathion scheduled to arrive Mekele on Saturday 9, July 1994.

-3 flights were chartered from Ethiopian Airlines to move pesticides, equipment, etc, from Addis Ababa to Shire, Axume and Mekele which include:-

13,200 lit of ULV
4,800 lit of Avgas
2,600 lit of Jet A-1
532 Knapsack sprayers

- 50,000 USD secured from UNDP New York is for services of Consultant and for spray services of Air Admas.

(b) Government

The Government using its own fund and funds obtained from donor communities obtained pesticides and equipment from the following sources:

Pesticides

-Carry-over of pesticides from 1993 crop season at the central warehouse of MOA amounting to 141,550 lit/kg.

-49,800 lit of pesticides donated by the Japanese Government under KR2 1992 grant and 38,800 lit/kg of pesticides donated by the republic of Korea.

-SIDA funded one Million Birr which enabled purchase of 32,800 lit of pesticide from AISCO.

-7,400 knapsack sprayers, 50,000 pieces of dry cell batteries purchased from Government fund and one Million Birr for operating expenses were allocated.

-719 knapsack sprayers procured from ERRP.

-Japanese Government Grant under KR2 1993 amounting to 88,600 lit in six containers have arrived in Djibouti and one of the containers that moved to Addis Ababa is in the process of clearance from customs office.

Agenda Item Three

Requirements for control of Armyworm

The report of Ministry of Agriculture forecasts occurrence of reinfestation in the northern parts of the country particularly in Tigray Region, Wollo and Gonder zones of Region 3. The areas estimated to be affected by the second generation of armyworm outbreak in the above mentioned areas are over 140,000 hectares. Pesticides previously delivered are already exhausted for control of first generation of armyworm outbreak. Therefore, the need for pesticides, spraying equipment and protective clothing for the control of the second generation of armyworm outbreak amounts to 176,400 lt/kg of pesticides, 500 spraying equipment and 500 pieces of overall, gloves and Goggles . The fund required to cover the cost is estimated at 1.9 Million USD. The meeting after thorough discussion on the subject, finally suggested to MOA to provide a project proposal for donors to consider for possible funding.

Agenda Item four

Donor pledges

FAO/TCP is to provide fund for the purchase of pesticide and application equipment. The project is to be approved in the next few days.

Agenda Item Five

Other Business

- MOA to quickly act to move the remaining pesticides in Djibouti to Addis Ababa donated by Japanese Government.

-UNDP/EUE to check with New York whether the fund earmarked for armyworm control could be used for the purchase of pesticides and equipment.

-MOA to provide to donors a project proposal indicating the requirements with detailed specifications of the items.

APPENDIX 8. Correspondence: Two letters from Dr. Teketel Forssido, Minister of Agriculture for Ethiopia, to USAID/Addis Ababa requesting pesticides; a table from the Ethiopian Ministry of Agriculture listing needs; and the USAID response. August 1994.

AGC4

DATE 10/8/94

Dr. Margaret P. Bonner
Mission Director
United States Agency for International Development
P.O.Box 1014
Addis Ababa

The Transitional Government of Ethiopia
Ministry of Agriculture

15 AUG 1994

Dear Dr. Bonner;

This is in reply to your letter dated 15 June 1994 regarding the availability of two million liters/kg of pesticides at AISCO stock and other issues raised in the letter.

As you are aware, a very serious African armyworm outbreak has threatened food production in several parts of the country this year more than ever before. Since it is the responsibility of the Government to control migratory pest outbreaks such as locusts, African armyworm and quelea birds, the Ministry of Agriculture has taken the necessary measures including timely distribution of pesticides and spraying equipment to all outbreak areas to prevent crop losses that were likely to occur. Furthermore, the international donor community has been regularly briefed concerning the outbreak situation and the efforts being made through armyworm task force meetings chaired by FAO. As USAID mission to Ethiopia has been actively participating in the task force meetings through its representatives, we believe it has clear picture of the situation.

It is. however, unfortunate that you have come across UNDP/EUE paper which does not give clear picture of pesticides currently available at AISCO stock. The correct amount of pesticides that AISCO has for armyworm and other chronic insect pest control is only 140,000 liters/kg, not as quoted two million liters/kg. Out of the total amount available 17,600 liters were procured through the fund donated by SIDA and has been distributed to the armyworm outbreak areas.

The other issue that needs clarification is the question raised concerning the use of pesticides in the country. Within the Ministry there is an office that regulates the importation, sell and use of pesticides in the country. This office carries its activities according to the Pesticide Registration and Control Special Decree No. 20 issued on September 1, 1990. There is fairly sufficient information concerning the use of pesticides in the country.

Despite wide area coverage by the first generation of armyworm outbreak, estimated over 869,040 ha, effective control measure has been undertaken on 194,648 ha using 172,513 liters and 40,340 kg of pesticides. However, a network of pheromone and light traps installed in different parts of the country indicates the occurrence of re-infestation in areas well over 140,000 ha in the northern part of the country. Moreover, the ecological conditions in these regions are considered favourable for locust outbreaks. These areas are already badly affected by drought, and the Government is undertaking massive food aid program through the international assistance. Hence, to improve food supply situation in the country, pesticides and spraying equipment required for armyworm and other chronic pest control is urgently needed. We believe your office will positively respond to our request as it has done during locust outbreak period of last year.

Accept, Dr.Bonner, the assurances of my highest consideration.

With best regards,

TEKETEL FORSSIDO (Dr.)
A/MINISTER

The Transitional Government of Ethiopia
Ministry of Agriculture

cc: FAO Resident Representative in Ethiopia
Addis Ababa

Are these registered for use against AAW?

10/8/94

EMERGENCY ASSISTANCE REQUIRED FOR MIGRATORY PEST CONTROL IN ETHIOPIA

ITEM	UNIT	QUANTITY	ESTIMATED UNIT PRICE US$	TOTAL
1. Insecticides				
Carbaryl 85% WP	Kg	40,000	7	280,000
Malathion 50% EC	Lt	40,000	7	280,000
Fenitrothion 95% ULV	"	50,000	10	500,000
Chlorphphos 24% ULV	"	50,000	10	500,000
Sub - total				1,560,000
2. Spraying Equipment				
Knapsack sprayer	Pcs	1,000	50	50,000
ULV sprayer	"	4,000	40	160,000
Sub - total				210,000
3. Safety Device				
Overall	Pcs	500	20	10,000
Gloves	"	500	10	5,000
Goggles	"	500	10	5,000
Sub - total				20,000
Total				1,790,000

100, 12/126/11/126
DATE 15/08/94

AGE-4

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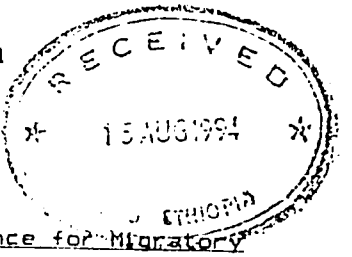
The Transitional Government of Ethiopia
Ministry of Agriculture

Dr. Margaret P. Bonner
Mission Director
United States Agency for International Development
P.O. Box 1014
Addis Ababa



Dear Dr. Bonner;

Subject: Emergency Assistance for Migratory Pest Control

Food production in many parts of Ethiopia was threatened by the African Armyworm infestations during the current crop growing season. The total land area that has been threatened is over 1.2 million hectares.

Pesticides

The tremendous food losses that were likely to occur have been prevented through the efforts made by the farmers and all concerned organizations. The Ministry of Agriculture distributed well over 140,000 lt/kg of various types of types to the regions before the outbreak occurred. The Ministry also procured and distributed 6,480 pieces of knapsack sprayers from the Agricultural Inputs Supply Corporation (AISCO) and 50,000 pieces of dry cell batteries. Over Birr one million was also dispatched to the outbreak areas to cover part of the operating expenses.

Pesticides

Similarly, various governmental and international organizations have also played an active role in the armyworm control operations. The Government of Japan through its KR-II 92 and 93 program and the Republic of Korea donated large quantity of pesticides for use in the armyworm control. In addition, SIDA funded local purchase of 32,800 lt of pesticides. Furthermore, funds were secured through UNDP/EUE from the governments of Switzerland, Netherlands and Norway as well as SIDA and UNDP for hiring Admas Air spraying aircraft and transporting pesticides to Tigray Region both by air and trucks.

From the financial and material support obtained from all those concerned extensive control operation was undertaken on 279,113 ha using 239,305 lt and 49,841 kg of various types of pesticides. Out of this, some 80,000 ha were treated using DLCO-EA and Admas Air spraying aircrafts. Substantial area of pasture lands was also saved from the armyworm destruction using various traditional methods.

Action Officer ANR/Tadele FMA
Action Due Date

Due to wide area coverage of this year's infestation, large quantities of pesticides have been utilized for the armyworm control. As a result, pesticides that were available in the country, particularly ULV formulation have been exhausted. The only ULV formulation that would be available in the country is 20,000 lt that is in the process of being procured from the FAO/TCP fund.

In light of this development, the Ministry kindly requests USAID to assist in obtaining pesticides required for migratory pest control. The type and quantity of pesticides, spraying equipment and safety devices required are enclosed here with.

The Ministry highly appreciates the efforts made by USAID in the control of locusts last year.

Sincerely,

TEKETEL FORSSIDO (Dr.)
A. MINISTER

00.27 - 5.e

UNITED STATES
AGENCY FOR INTERNATIONAL DEVELOPMENT
MISSION TO ETHIOPIA

BOLE-AMCE ROAD
P. O. BOX 1014
ADDIS ABABA
TELE : 610666
FAX : 613801

Pesticide regulation — last page, but nothing about registration or disposal.

August 17, 1994

Dr. Teketel Forssido
A/Minister
Ministry of Agriculture
Addis Ababa

Dear Dr. Teketel:

Thank you for your letters of August 10 and 15, 1994, reference numbers 12/126/11/124 and 12/126/11/126, regarding the status of your Ministry's efforts to combat the current armyworm infestation and the state of pesticide stocks in the country. As you state in your letter, USAID has participated in the FAO-hosted task force meetings on the armyworm situation. We have been very impressed by the effectiveness of your control efforts to date. Field reports suggest the current outbreak has been dealt with and that crop losses are not serious.

We share your concern that additional, second generation outbreaks are a possibility. Given the low in-country stocks of ULV, a second infestation would be difficult to control. Unfortunately, USAID is not able to provide additional pesticides at this time.

As you are no doubt aware, the U.S. government's regulations concerning pesticides are quite stringent, although they do allow us to provide pesticides if necessary procedural hurdles are overcome. The first requirement is that we undertake an environmental impact assessment prior to any pesticide procurements. These assessments are often very targeted, as was the one completed last year for locusts which enabled USAID to provide pesticides for locust control operations in 1993. The scope of the earlier assessment enabled USAID only to provide pesticides in response to locusts.

In recognition of the on-going threat posed to Ethiopia by a number of migratory pests, the Mission has asked our colleagues in Washington to undertake a broader environmental assessment which, if it finds local handling and storage procedures satisfactory, would enable USAID to respond to a broader list of pests. If the current plans hold, a USAID entomologist should be arriving to undertake the assessment in October.

..../

USA ADDRESS: ADDIS ABABA, (ID), DEPARTMENT OF STATE, WASHINGTON, D.C. 20521-2030

It is important to stress, however, that any pesticides provided by USAID at this time will be in the context of immediate threats and cannot be in response to the general need for pesticides in the country. Efforts to address such broader issues must be in the context of our longer-term development program which, as you know, is still being developed in coordination with your staff.

I hope this response is helpful to you. We will contact you and your staff again as the date of arrival for our entomologist nears.

Sincerely,

Walter North
Acting Director

USAID:FHA:MTHARVEY/tgm

CLEARANCE: MHANRATTY: MH. (08/17/94)

TADELLEGS: (08/17/94)

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APPENDIX 9. Letter from Dr. Andrew Harvey to Dr. Allan Showler. August 25, 1994.

FAX USA 703 235 3805 TCP/ETH/4454(E)

TO: DR. ALLAN SHOWLER, AELGA,
DISASTER RESPONSE CO-ORDINATION OFFICE,
USAID
WASHINGTON DC

Pesticides issues - esp storage - Nothing on registration or disposal

FROM: DR. ANDREW HARVEY
(ARMYWORM CONSULTANT)
FAO,
ADDIS ABABA
FAX ADDIS ABABA 515266

Dear Dr. Showler,

I am writing to you at the suggestion of Mike Harvey, USAID, Addis Ababa in connection with migratory pest contol operations in Ethiopia

I am here in Addis at the moment as a consultant to FAO on armyworm control, following the recent serious outbreaks and am hoping to make recommendations for a coherent strategy to deal with what is clearly a recurrent problem

I understand from Mike that USAID would require an environmental impact assessment before providing any further assistance with pesticides. From what I have seen during my visit there are a number of important issues that would relate to this:

Pesticides

1) Storage It is important that pesticides are not stored where they constitute an actual or potential hazard, nor in conditions in which they are likely to deteriorate. Store managers need to be trained in the specific problems of handling pesticide stocks

2) Aerial Spraying Large scale aerial applications have caused serious damage to honey bees, an important source of income for small farmers. It is also apparent that in some places, dwellings have been sprayed There is the additional question of whether all the areas sprayed were infested at a density which justified control and whether the operations were carried out in time to prevent damage

3) Distribution of Chemical through Extension Service Fenitrothion 96% ulv has been distributed for use by farmers and other unsuitable products have been used in response to pressure to provide something This is particularly worrying as little or no protective clothing is available to the people who will actually be handling and using the chemical

4) Application Rates From my previous experience , I reckon that recommended application rates for most insecticides are at least double what is necessary for armyworm control. There is a need to carry out trials to establish minimum dosage rates. There is also the problem of over-dosing by inexperienced operators

Now that this year's campaign is over, it seems a good time take stock of the whole problem Ethiopia will almost certainly need regular assistance from donors in dealing with locust and

armyworm infestations for some time to come. It therefore seems sensible to try to establish a system that it would be legitimate to continue to support

I am drafting two proposals, one relates to the establishment of an armyworm forecasting system based on a national network of pheromone traps and including training for crop protection specialists in the extension service The other is for the construction of purpose-built strategic pesticide stores.

I already have in front of me a request from the Minister of Agriculture for $1 56 million worth of pesticide and a further $230,000 worth of spray equipment and safety clothing. I want to link this to the construction the stores, as follows:

"If Ethiopia is to be able to mount prompt and effective control operations, there need to be strategic stores, each with a capacity of 50 tons at Dire Dawa and Mekelle Each store should have the following features

1) In the event a serious accident, such as a fire, the entire contents of the store would be retained within its structure.
2) All contaminated washings and waste should be retained within evaporation pans (one each for water and oil) and not be discharged into the water system
3) It would provide optimum conditions for storage of chemicals
4) It would be equipped to deal with any accident (including fire) spillage or contamination
5) It would be equipped to repack and relabel pesticides for distribution in small quantities
6) It would be equipped to repair and maintain spray equipment.
7) There would be a system of management that ensures that stocks are used in rotation and not allowed to deteriorate.
8) The staff would have received training in safe pesticide handling and management "

Does USAID?

I should like to know whether this conforms to your requirements and also whether you have any precise specifications for storage conditions that I could incorporate into the proposal I feel that if we could all pull in the same direction, we might be able to achieve something. I should therefore be very grateful for any comments that you may have on this or indeed anything else that has a bearing on these issues, such as field trials to establish which products and at what dosages would provide effective control with minimum environmental damage.

Yours sincerely,

Andrew W. Harvey

cc Mike Harvey USAID.

APPENDIX 10. Armyworm Emergency Operation in Tigray. Report of UN-EUE consultants Dr. Wolfgang Meinzingen and Dr. Robert Shank. August 1994.

EMERGENCY UNIT FOR ETHIOPIA

Armyworm Emergency Operation in Tigray

Dr. Wolfgang Heinzingen, UN-EUE Consultant
Dr. Robert Shank, UN-EUE Field Officer
August 1994

Biology and Epidemiology

The African armyworm is the larval stage of the night flying moth, Spodoptera exempta. The larvae or caterpillar, when occurring in large numbers, can consume rangeland grasses or wheat, barley, teff, maize, sorghum or finger millet crops faster than 400 head of cattle per hectare. After molting through six stages or instars over 14-22 days, the larvae pupate in the soil to emerge as moths which reinfest at the same place or several hundred kilometers downwind.

The seasonal cycle of the armyworm begins with the low density breeding of dry-season populations in the cool, coastal highlands of Kenya and Tanzania. These small populations of the solitary phase, which do little crop damage, occur in scattered grassy areas where it is not economical to spray or control them. As the Intertropical Convergence Zone begins moving northward causing the annual onset of the Meher rains, the strong winds accompanying the thunderstorms carry some moths to the interior highlands where primary outbreaks occur. Although not fully understood, it is here that the biological mechanism whereby a solitary pest transforms into the 40 times more active gregarious form takes place. It is thought that climatic changes at the onset of the rainy season, particularly when following a drought season, result in production of abundant forage which may trigger some response in the females laying the eggs. Because each female can lay 800-1000 eggs, as few as 30 moths could cause a serious outbreak of 15 million armyworms within two generations or two months.

During 1994, there were medium to large outbreaks in late March to early May in the Coastal, Nyanza and Rift valley provinces of Kenya which were monitored by the Desert Locust Control Organization (DLCO) and sprayed by the Kenya Plant Protection Department. By mid-April major secondary outbreaks were causing serious damage in Eastern and Northern Uganda and Southeast Sudan. The first outbreaks in Ethiopia were recorded in Borena on 18 April, but not until mid-May did the movement encompass all of the Southern, Southwest, Ogaden and East/West Hararge areas. By 17 June, it was evident that a major control operation was needed as 240,000 hectares were affected and 170,000 liters/kilograms of pesticides were being distributed to the zonal capitols of the appropriate Regions (Table 1).

Developments leading to the Northern Campaign

Pesticide

The MoA-Plant Protection in Dessie reported low moth numbers in light/pheromone traps at Kamisa, Kombolcha, and Dessie but were prepared with 6,600 liters/kg of insecticide and 124 hand sprayers. On May 24, 7,065 hectares (1066 hectares being grassland) were 10-20% infested and 1,314 hectares were already sprayed. However the Meher rains were delayed in the eastern escarpment areas and most maize and sorghum plantings were severely moisture stressed, thus providing little forage for the armyworms. Planting of short season crops had not yet begun so there would not have been substantial crop damage from armyworm even if outbreaks occurred.

On 15 June, Dr. Robert Shank of the EUE began a forecasting survey of South and North Wello and Tigray as reports were already being received of heavy infestations affecting about 40,000 hectares on the Gojjam-Gonder side.

Pesticides

In North Wello, the agronomist at Weldiya reported 5,559 hectares affected with 2,500 already sprayed. At hand were 32 sprayers and 5,900 liters/kg of pesticide. At Robit and Kobo, in North Wello, moth traps were being neglected and numbers were not being recorded. Again sorghum and maize crops were nearly beyond hope of recovering even if rain would come. Farmers expected to use the stalks as forage and replant teff or pulses when rainfall came.

In Region 1 (Tigray), there were moth counts of 831 on 3 June from the Western zone (Shire)and reports of 24,500 hectares affected (7,000 being cropland). A radio call on 24 June of an additional 5,000 hectares of affected cropland signaled an impending severe outbreak.

Pesticides

In the Central zone of Region 1, in Axum, a total of 3,500 hectares were affected. Five thousand litres of pesticide were sent to the zonal offices (2,200 to the western zone) and requests for additional assistance to the MoA-Addis Ababa brought the dispatch of 2,000 liters of pesticides. The DLCO spray plane arrived around 21 June. Ten drums of AvGas and 2,000 liters of pesticide were dispatched by DLCO to Mekele and Humera on 17 June.

Supplies Diminishing and Outbreaks Expanding

Pesticide

On 17 June, at the regular FAO/DLCO/MoA meeting, it was reported that the outbreak of armyworm covered large areas of Borena, southern Bale, practically all of Hararge and Jijiga, Sidamo and the Omo area and parts of Jima and Welega. It was feared that pesticides of the MoA would be exhausted and an appeal was made to FAO and the donors for $897,000, $500,000 of which was for the purchase of chemicals, the rest for sprayers and safety equipment. The FAO agreed to contact Rome on an emergency basis but no donors were found.

On 30 June, at a specially called FAO meeting on the armyworm control campaign, while the spraying operations were known to be

diminishing in the Hararge, South and Southwest, the report of 2,392 hectares affected by June 17 in Region 1 had grown to more than 40,000 hectares and was expected to reach 75,000 hectares by 4 July. Chemical supplies of the MoA-Plant Protection Department were said to be exhausted. The government had allocated Birr 1 million for spraying expenses. A recent donation of about 32,000 liters/kg of pesticides from the Government of South Korea had already been cleared through customs and allocated to the areas being sprayed. It appeared that all resources had been exhausted and the campaign would soon end for lack of donors support for additional pesticide purchase. Shortly after the meeting, SIDA donated 1 million birr for the purchase from AISCO of 32,800 liters of pesticides.

Pesticides

Airlift and Aerial Spraying Operations Organized by EUE

With the knowledge of the strain already being placed on the single DLCO spray plane and an understanding of the historic food shortages in Region 1, it became apparent that help would be needed to transfer pesticides to Tigray and apply them in time to prevent severe crop damage. The window of time for application of pesticides in the case of armyworm is 7-10 days depending upon whether the infestation is spotted in the early instar stage and the air temperature where the larvae are developing. Dr. Meinzingen, the former head of the FAO regional migratory pest control project, was requested by FAO and the UN/EUE to come to Addis on 30 June for a 17 day consultancy to assist in forecasting and verification of outbreaks, coordination of aerial control operations, donor awareness and solicitation, and training of local personnel in forecasting and control operations.

Pesticides

Based on the report that 8-10,000 hectares were affected in the Humera area where UNHCR is resettling refugees, an emergency appeal was made to the Swiss Government to hire an additional spray aircraft from Ethiopian Airlines Spraying Service Unit (EA-SSU) and to transport fuel/pesticides to the area. The grant was received by Friday, July 1, the spray plane contracted on July 2 and moved to Axum 3 July for spraying 4 July. By that time, the infestation in Humera had pupated and the area affected around Axum and Shire had expanded. Therefore, it was decided to deploy the EA-SSU in this area with the following specifications:

	DLCO	EA-SSU
Fuel capacity	100 ltr	250 ltr
Fuel consumption	80 ltr/hr(Avgas)	180 ltr/hr(Jet A-1)
Chemical capacity	400 ltr	1200 ltr
Application rate	.5 ltr/ha	.5 ltr/ha
Area Sprayed (ave 5 hr day)	500 ha/hour	1000ha/hour[1]
Gross support supplies	1.6 MT/day	3.4 MT/day

[1] The area sprayed is larger due to air speed and the larger chemical tank necessitating fewer returns for refilling.

The rates charged by the EA-SSU are as follows:

-Spraying-	5208 birr/hr
-Ferry (to and from refilling site)	2435 birr/hr
-Idle	1826 birr/hr

-Guaranteed equivalent of two hours spraying/day unless weather/mechanical restrictions

With stocks of fuel and pesticide low in the area being sprayed, it was necessary to assist the MoA logistically in order to facilitate deliveries. Subsequently, an Ethiopian Airlines DHC-5 cargo aircraft was chartered by the UN-EUE to transport the necessary cargo. The chartered flights were scheduled on several occasions carrying the following cargo:

Friday, 8 July, 1994
Schedule: Addis - Shire - Axum - Mekele - Axum - Addis
Cargo: Shire - 800 litres Avgas & 1000 litres ULV pesticide
Axum - 1600 litres ULV & 2600 litres Jet A-1

Saturday, 9 July, 1994
Schedule: Addis - Shire - Mekele - Addis
Cargo: 2400 litres ULV & 800 litres Avgas

Sunday 10 July, 1994
Schedule: Addis - Shire - Mekele - Shire - Addis
Cargo: 800 litres ULV & 1400 litres EC
(cargo from Mekele not known)

On 7 July, two trucks were dispatched from Addis Ababa, one by the MoA, transporting 6 drums (1200 litres) of Avgas and one by UN-EUE with 17 drums of ULV, 32 drums of malathion EC insecticide and 3,100 kgs of Carbaryl insecticide, the latter two allocated for ground application.

On 9 July, an Ethiopian Airlines Hercules was chartered to airlift 6000 litres of ULV, 3200 litres of Avgas and 532 backpack sprayers from Addis Ababa to Mekele. Transportation and distribution of this pesticide from Mekele to Axum, Shire and other places in need of spraying was by road.

Table 1. Area infested by Armyworms and area sprayed by region as of June 17, 1994[1] and as of July 10 (in Bold).

Region	# of Zones	# of weredas	Hectares Infested	Hectares Sprayed	Liters Insecticide	Kiligrams Insecticide
1	2 **4**	6 **27**	2,392 **75,000**	1,200 **18,522**	698 **6,967**	661 **664**
3	7 **7**	62 **75**	43,102 **155,392**	7,861 **17,392**	6,881 **14,167**	980 **3,526**
4	11 **12**	92 **92**	87,077 **510,025**	57,940 **74,048**	55,638 **90,041**	7,440 **16,595**
5	1	5	40,000 **43,740**	7,000 **12,840**	8,850 **13,000**	0
6	2	5	15,000 **15,564**	2,036 **3,644**	2,130 **2,200**	325 **985**
Southern Peoples	10 **11**	39 **58**	46,773 **50,000**	15,675 **26,104**	12,238 **22,156**	4,733 **10,420**
13	1	13	1,215 **10,225**	1,215 **1,803**	920 **1,040**	550 **575**
Dire Dawa	1	2	4,674	4,674	3,722 **4,045**	1,900
Total	35 **38**	219 **264**	240,234 **869,044**	99,202 **159,028**	91,079 **153,616**	16,630 **34,665**

[1]Source- Ministry of Agriculture-Sholla Plant Protection Laboratory

Table 2. Aerial spraying operations in West and Central Zones of Region 1 (Tigray) from 28 June to 10 July, 1994.

	Axum Zone		Shire Zone	
Date	DLCO	ESS	DLCO	ESS
6/28			2400	
6/29			1200	
6/30				
7/1			pilot sick	
7/2			" "	
7/3	1200			
7/4				En Route
7/5	1400			1600
7/6			600	
7/7		3200		
/8		Rainy	Fog-Rain	
7/9		4000	2000	
7/10		2000		

Current situation, Forecasting and the Farmers response

During the course of control operations, all remaining stocks of ULV in the possession of the MoA and the AISCO were moved to the aerial operation sites. An additional 30,000 litres donated by the Government of Japan arrived at this point, to be processed and cleared for deployment in the affected region. Table 2 shows the areas that had been surveyed for spraying as of 8 July in Axum and Shire. Hand sprayers and EC pesticides for the operation were to be distributed from the available stocks previously transferred to Mekele. A remaining 20,000 hectares was to be hand sprayed in the Axum area and already targeted 26,000 hectares plus an additional 9,065 in the Shire area. Further increases in infestation in already affected areas were still expected although the worst was thought to be over with the observed decrease in moth numbers and the start of moderate rainfall which was perceived to be beneficial to crop growth but not for small armyworm larvae.

However, since rainfall had just begun in the Eastern and Southern Zones of Tigray as well as North and South Wello, at this point, outbreaks needed to be monitored through moth trappings and field observations. In fact, new outbreaks were still being reported in pocket areas of the Timbien area west of Mekele. Also, in Humera area, there was 8000 hectares of 1st generation larvae that was not sprayed so the larvae pupated in the ground and upon emergence could infest locally or move on to more northern areas.

Table 3. Areas Surveyed for Aerial Armyworm Spraying in the Central and Western Zones of Region 1 (Tigray) as of 8 July.

Central Zone (Axum)		Western Zone (Shire)	
Wereda	Area (hectares)	Wereda	Area (hectares)
Chila	3000	Adinebred	6118
Adi Arbaete	3301	Ade Hageray	4929
Adi Abun	1476	Ade Daero	4379
Edamariam	756	Medebai	2556
Maikintel	500	Asgede	7901
Endaba Tsahma	1600	L/Koraro	1925
Enticho	2711	T/Koraro	1710
		MaiTsebri	3710
		Adi Wasla	1270
		Tsimbla	243
Sprayed	12,000	Adi Remetz	324
Total	24,400		35,065
Sprayed as at 15/07	12,000		11,200
Allocated	12,000		14,800
Area infested suitable for aerial but ULV exhausted	400		9,065

Moth traps

Pheromone moth traps are considered to be the simplest and least expensive method of predicting armyworm outbreaks. With this method, the synthetic female hormone attracts the male moth of only the armyworm, whereas light traps in addition to requiring electricity, attract many other species. When the number of male moths reaches 30 or more per day, a light outbreak becomes eminent within 7-10 days and second generation outbreaks occur which can be severe. During severe outbreaks, moth counts in the range of hundreds of moths per day are common.

Limited data on moth counts in several areas were made available to the author. Some trapping stations aggregate several days counts when emptying or reporting data. This makes it impossible to accurately predict exactly when outbreaks are likely to occur. Also, it distorts the pattern of a normal cycle of an outbreak. Although moths usually arrive with the winds of strong thunderstorms, if the storms occur over a period lasting several days, the breeding and egg laying may also be spread over a period of time and therefore, the rate of larval/pupal growth will become temperature and food-source dependent. Such factors tend to spread out moth counts for the second and subsequent generations. As all outbreaks in the regions, with the exception of Addis Ababa, occurred within a few days of the sharp rise in moth counts, they could have been forecast based available data. In highland areas such as Addis Ababa, moths arrived early enough to be detected and in large enough numbers to cause outbreaks but mating, egg laying and larval development were delayed and impeded by low temperatures.

forecasting

The knowledge and control activities of the local farmer has proved to be remarkable. Farmers were warned of possible outbreaks by radio but as one farmer reported, he was already fore-warned by observing the number of moths flying into the light of his evening coffee ceremony fire.

It is interesting to note from Table 4, the differences in the control practices of local farmers in comparison to the area covered by the airplanes as shown in Table 2. Cultural control is practiced mainly in regard to grassland outbreaks and consists of collecting larvae by hand which is sometimes fed to chickens, thrashing the area with thorn bushes or trampling with cattle. The area covered by either cultural control or ground spraying was small probably due to the early stage of the outbreak in Region 1 at the time of control. One farmer who was very encouraged to see the spray airplane remarked, In the past, airplanes came to kill us; this time it was good to hear the airplane coming to kill our enemy."

Economics of Armyworm Control and Lessons to be Learned

Armyworm control will be an expenditure that the transitional government had not planned for and could do without. Immense loss

was experienced through the use of several hundred thousand litres/kg of chemicals, costs of aerial and ground applications and the extensive manpower and labour directed toward saving crops rather than increasing production. Close to 1 million hectares may face reduced production due to complete or partial loss of crop leaf synthesizing area. CARE alone has been searching for short season crop seeds to replant 12,000 hectares of devastated crops, while expecting about 50% reduction in yield due to shorter season crops. Also, many areas which normally have poor weed control will experience drastic broadleaf weed growth (not affected by armyworms) due to reduced cereal crop stands.

It may initially seem to be an expensive operation to airlift chemicals and fuel into areas that could also be supplied over land and with timely prepositioning. Also, utilization of the potential of the two aircraft was disappointingly low. However, when comparing the overall cost of the operation to the number of hectares of crop recovered, the operational cost averaged $4 per hectare. Assuming the mixture of maize, sorghum and finger millet will average 10 quintals or 1 ton per hectare, the cost for a the programme to replacing this tonnage on site would be about $130. The operation was therefore, both a reasonable investment and a move that spared Tigray, and possibly, Eritrea from catastrophe.

This brings us to lessons that we should recognize intellectually if not financially. It was after the drought of 1888-92, again in 1984, and now in 1993 that armyworm exercised its devastating effect with a migration across East Africa. Experts were fully aware of the problems in Kenya, Uganda and Sudan long before it reached Ethiopia. Possibly, the reluctance to become implicated in matters involving hazardous chemicals has been due to growing environmental awareness. Therefore, endemic organizations were not encouraged to preposition chemicals in the countryside to challenge this migratory pest.

In the words of one 1993 crop assessment expert, "Africa will have to become familiar with the agrichemical era in order to ensure the reliability of its much needed food supply".

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Table 4. Armyworm infestation by crop and on-the-ground control activities in the Western Zone (Shire) as of July 7, 1994[2].

Wereda	No Tabias	Area in Hectares Millet	Sorghum	Maize	Pasture	Total	Cultural Control	No People	No Animals	liters chemical	Hectares Sprayed	Total
Adinebred	10	3216	2088	814	193	6311	2	29	-	137	170	172
Adehageray	9	1754	2553	622	1944	6873	7	320	690	98	102	102+
Adedaero	6	1944	756	1697	1098	5477	33	5013	10783	55	162	195
Medebai	9	1692	496	368	1475	4031	104	3033	693	297	310	414
Asgede	9	3231	1244	3426	7475	15376	2	24	18	45	38	40
L/Koraro	6	1342	360	223	665	2590	17	602	200	46	49	66
T/Koraro	3	510	350	850	620	2330	11	80	350	24	24	35
Maitsebri	17	2180	1140	390	2354	6064	221	791	1535	230	298	519
Adiwasa	9	601	637	32	1325	2595	23	108	1847	63	60	83
Tsimbla	8	111	44	88	72	315	-	110	-	11	23	23
AdiRemetz	?	220	104	-	-	324	6	120	-	96	76	82
Total		16801	9772	8510	17221	52286	419	10230	16116	1102	1312	1731

[2]Data provided by Zonal Ministry of Agriculture

APPENDIX 11. FAO armyworm project proposals. Sept. 28, 1994.

联合国粮食及农业组织
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION
منظمة الأغذية والزراعة للأمم المتحدة

THE OFFICE OF THE FAO REPRESENTATIVE IN ETHIOPIA
P.O. BOX 5536 TEL. NO. 15-3 4-87 ADDIS ABABA

FAOA - 1495/94
DL/17/2

28 September 1994

- Donor assistance, FAO
- Major concerns
- Facilities Needed

- Pesticide issues, but nothing on registration

Dear Sir,

I am pleased to invite you to a meeting of the Armyworm Steering Committee to be held on Monday 3rd. October at 2:30 p.m. at FAOR office.

Dr. A.W. Harvey, FAO Armyworm Consultant, will present a report on the 1994 armyworm upsurge and proposals for strengthening the capacity of the Ministry of Agriculture to carry out emergency control operations against migratory pests in the future.

Major concern

Disastrous crop loss from armyworm during the 1994 season was only mitigated by a large-scale control operation, which had implications in terms of cost-effectiveness as well as possible impact on the environment. In many instances, control was too late to save the crop.

Major concern

There is normally a period of about ten days, between the larvae being first observed on the crop and it being destroyed, within which effective control can be carried out. This can only be achieved if there is pre- planned action by the extension service, based on forecasting outbreaks and distribution of pesticides and sprayers. If this action is not underway, initiated on the forecast of outbreaks, before farmers have reported infestations, the crop is much less likely to be saved.

Facilities & Expertise Needed

Two project proposals have been drafted (copies enclosed). The first is technical assistance to establish a national armyworm forecasting unit within the Plant Protection Laboratory and also to initiate training of extension workers in recognition, reporting and control of armyworm outbreaks. The second is to provide a strategic stock of pesticide to be held in the country for migratory pest control. In view of the problems in managing pesticide stocks, especially the environmental hazards posed by poor storage and the accumulation of obsolete materials, the project also provides for the construction of purpose-designed and fully equipped insecticide stores and for training the store managers in all relevant aspects of pesticide management.

Confirmation of your attendance will be highly appreciated.

Your faithfully,

S.S.Mahdi
FAO Representative a.i. in Ethiopia

Mrs. Ashton Douglass
Humanitarian Assistance
USAID
Addis Ababa

Action Officer FHA

Country:	ETHIOPIA
Project Title	Assistance to Establish Armyworm Forecasting System
Project Number:	TCP/ETH/####
Starting Date	March 1995
Duration	Six months
FAO Contribution.	US$174,000

PROJECT SUMMARY

Spodoptera exempta (Walker) is a migratory moth whose larva is the African Armyworm, a serious pest of cereal crops and pasture grasses in sub-Saharan Africa. Migration into Ethiopia from East Africa with the northward movement of the Inter-Tropical Convergence Zone causes regular outbreaks. In some seasons, especially following drought, outbreaks can cause widespread and serious crop damage, thereby threatening food security.

The 1994 rainy season saw the most serious level of infestation in the experience of national crop protection officials and serious damage wasaverted only by emergency assistance from the international community.

There is a need to establish a sustainable system to deal with what is in fact a recurrent problem, though not usually of the severity seen in 1994

The project will establish a national armyworm forecasting unit in the Crop Protection Laboratory and will carry out training of extension staff to ensure that armyworm outbreaks can be controlled promptly, effectively and safely.

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I BACKGROUND AND JUSTIFICATION

The African Armyworm (*Spodopera exempta*) is the larva of a noctuid moth. It feeds exclusively on the leaves of graminaceous plants and is a serious pest of cereal crops and pasture grasses. The moth is highly migratory and its life-cycle is adapted to exploit the favourable conditions for larval survival which are created by the movement of the Inter-Tropical Convergence Zone(ITCZ) across the grassland areas of Africa.

The life-cycle is very short, usually about five weeks but sometimes as little as four. A female moth may lay two or three egg masses of about 300 eggs each. The total number of eggs produced by a female moth may, in favourable conditions, reach 1000 (this gives a potential compound rate of increase of about 20% per day). There are six larval instars, which last a total of about 20 days. In areas where armyworm regularly occur, farmers spot the early instar larvae and often are able to carry out control before damage is done to the crop. However, larvae sometimes remain unnoticed until the fourth instar and this seldom leaves time to organise and carry out control before the fifth and sixth instar, during which the most serious damage is done. Control must be carried out before this stage if the crop is to be protected, and it is very difficult for farmers, especially small-holders who may be dependent on the extension service, to obtain pesticides and sprayers in time to save the crop. The extension service is also is likely to have difficulty in distributing these materials in time, especially in a country such as Ethiopia, in which communications to rural areas are difficult.

The 1994 armyworm season in Ethiopia was the most serious in the experience of crop protection officials. From April to July, successive generations of moths migrated northwards with the Inter-Tropical Convergence Zone to cause widespread and serious outbreaks on cereal crops in their early and most vulnerable stage of development. Since this occurred at the end of a serious drought, which required a major food relief programme, its implications for food seciurity in the affected areas are very great. Assistance from the international community to combat the plague amounted to $#,###,###, with $250,000 from an FAO project (TCP/ETH/4454). This assistance included the purchase and air-lifting of pesticides and carrying out of large scale aerial spraying operations. This assistance enabled the extension service to carry out control operations which prevented what could otherwise have been catastrophic crop loss.

FAO

Although plagues of the severity of 1994 are rare, armyworm outbreaks occur approximately every other year, especially in the southern part of the country. It is, therefore, a regular problem which may occasionally assume disastrous proportions. Since the majority of the population of Ethiopia are subsistence farmers dependent upon cereal crops, armyworm constitutes a perennial threat to food security.

If the time available for the extension service to organise control can be lengthened by forecasting the location and timing of the outbreaks, the chances of crops being successfully saved is greatly increased, especially if the forecast is followed by a pre-planned distribution of materials and field extension workers are adequately trained to recognise, report and control armyworm outbreaks.

What is therefore needed is a national strategy for armyworm control, based on:

i. forecasting,
ii. extension,
iii. the pre-planned distribution of strategically located stocks of pesticides, sprayers etc. pesticide issue

Armyworm forecasting is based on a knowledge of the insect's life-cycle and flight behaviour in relation to weather systems. In order to forecast outbreaks, the following information is needed:

i. the location of previous outbreaks and the date on which moths are expected to emerge from them,
ii. the prevailing winds and the position of convergence zones during the period when moths are flying,
iii. catches from moth traps, which confirm the presence of migrating moths and, in the case of pheromone traps, indicate where and when breeding is taking place.

During the rainy season, when armyworm outbreaks are possible, this information needs to be continuously collected and collated by a national armyworm forecasting unit and a weekly forecast issued.

Although an effective armyworm control strategy requires a national forecasting unit, exchange of information between countries plays an important part in anticipating serious upsurges. This is particularly true of Ethiopia, since moths migrate into the country from outbreaks further south. A regional armyworm forecasting system was developed in DLCO-EA during the Regional Armyworm Project. Its effectiveness has tended to be hampered by difficulties in communication between it and the national plant protection services. It is therefore desirable to give some assistance in strengthening regional forecasting and data exchange as part of the general objectives of the project.

Forecasts will not by themselves prevent crop loss. They must be linked to an effective response by the extension service. Field extension agents must warn farmers of the probability of outbreaks and actively survey for early instar larvae. Reports of outbreaks from extension agents must contain the information required by the forecasting service as well as that required to plan the local distribution of sprayers and pesticides. It is also the extension agents who will carry out control and assist farmers. They must be trained to do this effectively and safely. Pesticides

Armyworm outbreaks create a sudden local demand for pesticides and sprayers. Unless this has been anticipated and met before outbreaks are reported, there will be no time obtain further supplies before the crops have been destroyed. It is therefore essential that regions should hold strategic stocks and that they should be distributed to zonal level immediately outbreaks are forecast. By the time outbreaks are being reported, the materials should be ready for distibution to warada and kebele level. Appropriate facilities for storage and plans for distribution are necessasry for this. Pesticide availability / Use pattern

Adequate extension training ensures that outbreaks that are endangering crops receive prompt and correct treatment. This minimises the need for large-scale aerial application and will also tend to reduce unnecessary spraying and environmental contamination. Safety measure

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II OBJECTIVES OF THE ASSISTANCE

The objective of the assistance is to enable the Government of Ethiopia to reduce the threat to food security posed by periodic invasions of African Armyworm by developing a national strategy of armyworm control based on a system of forecasting and extension training

The outputs of the project would be an improved capacity to protect cereal crops against armyworm infestation and hence a reduced dependence on external aid in dealing with this problem

what about the pesticides?

III SPECIAL CONSIDERATIONS

1) Need to ensure food security.

Food security in Ethiopia is a matter of critical concern, since large scale famine relief operations have been made necessary in recent years as a result of a series of disasters, both natural and man-made

2) Need minimise dependence on emergency donor support.

The project will not abolish the country's need for external assistance with control of armyworm, but it will increase the efficiency with which such assistance can be used and perhaps reduce the need for it

3) Need to reduce large-scale aerial spraying. Environmental impact

The only control strategy available to deal with widespread outbreaks in inaccessible areas has been large-scale aerial spraying. It is apparent that this is open to a number of objections.

a. Aerial spraying has caused heavy losses of honey-bees, which are an important source of income to small farmers. Losses in one warada alone during the 1994 campaign are estimated to be in excess of $160,000.

b. Aerial spraying has been carried out without adequate ground surveys to ensure that they are justified. It is clear that areas have been sprayed unnecessarily and in other cases, after the armyworm have pupated.

c. Subsistence farmers tend to build their dwellings among their fields. It is therefore impossible to spray the fields without contaminating the dwellings, water-supplies, food supplies etc.

d. Aerial spraying is expensive.

pesticide safety

4) **Regional Data Exchange & Forecasting.**

Armyworm forecasting in Ethiopia requires information from other countries in the region. The institution mandated to mediate this is DLCO-EA (Desert Locust Control Organisation for Eastern Africa) Some assistance should be given within the project to support this aspect of its work.

Kenya, Tanzania, Zambia, Zimbabwe, Malawi, Swaziland, Botswana, Mozambique already use a common computerised armyworm database (WormBase) This system will be installed in Ethiopia as part of the project and it is hoped that Uganda will shortly adopt it also. This will provide a means of exchanging data files in a common format and it would therefore be desirable for DLCO-EA to maintain a regional database using the same system.

It has been proposed that the Ethiopian national meteorological service should become a regional centre for IGADD and so regional remote sensing data could be made available. The distribution of information derived from remote sensing products to other member countries of DLCO-EA could be a valuable role for the regional forecasting unit to play.

IV WORK PLAN

- Establish computerised armyworm database at Crop Protection Laboratory.
- Arrange provision of remote sensing and meteorological data by National Meteorological Service.
- Conduct training course for regional and zonal crop protection specialists
- Improve Reporting of Armyworm Outbreaks
- Strengthen DLCO-EA Regional Armyworm Forecasting Unit.
- Train Staff of Crop Protection Division in Management of Aerial Spraying Operations
- Provide recording and reporting forms and training booklets.

IV INPUTS TO BE PROVIDED BY FAO

Personnel (TOR's in Annexe)

One international armyworm consultant to establish a national armyworm forecasting unit and carry out training of extension staff. (6 man-months)

One international remote sensing consultant to develop automated transfer of remote sensing images to GIS in Crop Protection Laboratory

Technical Backstopping short technical assessment mission by AGPP staff member (max. 2 weeks) .

Official Travel

General Operating Expenses

Supplies and Materials

Print a supply of outbreak reporting forms for use by extension agents

Print a booklet on recognition, reporting and control of armyworm for use by the extension service.

Print an instruction booklet for the use of pheromone trap operators.

Print a supply of recording and reporting forms for light and pheromone traps.

Stationery

Equipment

See Annexe for list

Training Fellowships

2 Three-month training fellowships in aerial spraying technology for staff of Crop Protection Laboratory

REPORTING

usual

GOVERNMENT CONTRIBUTION AND SUPPORTING ARRANGEMENTS

usual

Nothing about pesticide regulation.

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PROJECT BUDGET COVERING FAO INPUTS

Consultant (armyworm) 6 man-months	$72,000
Consultant (remote sensing) 1 man-month	$12,000
Computer Equipment	$46,000
GPS (5) for Crop Protection Div.	$5,000
Office Equipment	$3,350
Scientific Equipment	$10,000
Training Equipment	$1,300
Printing of Reporting Forms & Training Materials	$5,000
2 3-month training fellowships	$35,000
??vehicle	$.....
Total	$174,000

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ANNEXE

TERMS OF REFERENCE

International Consultant (Armyworm)

Under the general supervision of the Senior Officer Migratory Pests, AGPP and in co-operation with the FAO Representative in Ethiopia, the consultant will:

Establish a computerised armyworm database at the Crop Protection Laboratory, Ministry of Agriculture, Addis Ababa and give training to staff in its use

Strengthen the national armyworm forecasting trap network by establishing new stations as required and give training courses to trap operators.

Design and arrange the printing of suitable recording and reporting forms for moth traps and armyworm outbreaks for use by trap operators and extension agents.

In consultation with national staff, prepare and print training booklets for trap operators and extension agents.

Conduct one week training course for regional and zonal crop protection specialists.

Duty Station: Addis Ababa
Duration of Mission, 6 Man-months (March-August 1995)

International Consultant (Remote Sensing and Geographic Information System)

Under the general supervision of the Senior Officer Migratory Pests, AGPP and in co-operation with the FAO Representative in Ethiopia, the consultant will:

Set up the IDRISI or IDA (as appropriate) GIS at the Crop Protection Laboratory to process data required to forecast armyworm and other migratory pests.

Devise procedures for extracting night-time 12-hour Cold Cloud Duration from Meteosat images and transferring them by modem for display by the GIS at Crop Protection Laboratory.

Devise procedures for extracting data on wind speed and direction received at National Met. Service through NMD and transmitting them to Crop Protection Laboratory.

Duty Station: Addis Ababa

Duration of Mission; 1 Man-month (May 1995)

ANNEXE

EQUIPMENT

3	Desk-top Personal Computers (Crop Protection Lab., Met. Service & DLCO-EA,):	
	8 mb RAM	
	500mb HD	
	SVGA graphics	
	mouse	
	modem	
	tapestreamer	$30,000
2	Colour Laser-Jet Printer (Crop Protection Lab. & DLCO-EA)	$10,000
Computer Software for PC's at Crop Protection Lab & DLCO-EA		
	Windows	
	WormBase	
	Idrisi/IDA	
	dBaseIV	
	Excel	
	Word for Windows.	$3,000
Computer consumables.		
	computer listing paper	
	floppy disks	
	tape cartridges	
	printer cartridges	
	storage boxes for diskettes and tapes	$3,000
5	High Quality Global Positioning Systems (Hand-held) for survey and locating trap stations.	$5,000

Moth Trap Equipment

500	Pheromone traps
10	Robinson Light Traps
100	Mercury-vapour bulbs dor light traps.
5000	Empty pheromone septa.
2 litres	armyworm pheromone blend
1000	DDVP toxicant strips for pheromone traps.
1000	Specimen bottles.
50	Aluminium containers for storing pheromone septa

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Office Equipment (Crop Protection Lab)

Photocopier	$3,000
Filing boxes for report cards	$200
Computer work-station	$150
total	$3,350

Training Equiment

1	Video player and monitor	$700
5	Video cassettes (to copy training videos)	$100
1	Overhead projector	$500
total		$1,300

Direct Operating Costs

Country:	ETHIOPIA
Project Title	Emergency Relief Assistance to Provide Stategic Pesticide Stores -
Project Number:	
Starting Date:	March 1995
Duration:	Twelve months

PROJECT SUMMARY

The 1994 rainy season saw the most serious level of infestation of the African Armyworm in the experience of national crop protection officials and serious damage was only averted by assistance from the international community in the form of emergency supplies of pesticide. Although this was necessary, food security was safeguarded at the price of environmental damage through widespread aerial spraying.

Migratory pests pose a recurrent threat to crops in Ethiopia. Aerial spraying against armyworm can be replaced with ground spraying by the extension service provided strategic stocks of pesticide can be pre-positioned for rapid distribution in time.

There is a need to jump-start a sustainable system to deal with what is in fact a recurrent problem. Part of such a system would be a forecasting unit in the Crop Protection Laboratory and training for the extension service in the control of migratory pests, these are the subject of a parallel project proposal. This project provides for an emergency stock of pesticides to be stored so as to be available for immediate use and to be neither wasted nor become a hazard.

As part of a national strategy to deal with migratory pests, the project will provide a strategic stock of pesticides and equipment and construct four purpose-built pesticide stores to enable them to be held at appropriate locations throughout the country. It will also provide training for staff in pesticide management.

Nothing on pesticide registration!

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I BACKGROUND AND JUSTIFICATION

Ethiopia is prone to invasion by two major migratory pests, the Desert Locust (*Schistocerca gregaria*) and the African Armyworm (*Spodopera exempta*) There are also other non-migratory pests, such as grasshoppers and the Wello Bush Cricket, which require emergency control operations which are occasionally beyond the capacity of the Ministry of Agriculture Since the majority of the population of Ethiopia are subsistence farmers dependent upon cereal crops, migratory pests constitute a perennial threat to food security, especially since serious upsurges tend to be associated with droughts.

In 1993, an invasion of Desert Locust required emergency assistance from the international community ammounting to $1 25 million and in 1994, Ethiopia suffered from the most serious infestation of armyworm in the experience of crop protection officials Assistance from the international community to combat the plague amounted to approximately $2 million with $250,000 from an FAO project (TCP/ETH/4454) This assistance included the purchase and air-lifting of pesticides and carrying out of large scale aerial spraying operations

Emergency operations against migratory pests must be timely if they are to be effective Delays caused by supply problems usually result in more extensive spraying being necessary later. In the case of armyworm, there is a window of about ten days between the larvae first being observed and it being too late to save the crop During the 1994 season, it was observed that aerial spraying had sometimes been carried out after the larvae had pupated The capacity to carry out timely control operations can therefore be expected to reduce the country's dependence on emergency assistance

It is therefore necessary to jump-start a sustainable strategy for combatting migatory pests Timely control is only possible if stocks of pesticide for migratory pest operations can be held at strategic points around the country and so the strategy should include the provision of a reserve stock of suitable pesticides and the construction of appropriately designed stores, in which they can be held, at key points in the country The project will therefore provide a main intake store, sited at Addis Ababa, with a capacity of 150 tons and three stores, sited at Dire Dawa, Bahr Dar and Mekelle, each with a capacity of 50 tons

However, the following problems associated with holding pesticide reserves for emergency operations have been observed

1) All pesticides have a limited shelf-life and, if stored for too long, lose their efficacy Since the cost of a litre of pesticide is seldom less than $10, this is a serious waste of resources

2) The packaging of obsolete or unused stocks may deteriorate to the point at which they cannot be moved or handled safely Leakage may also constitute a danger to workers, local people and the environment. In these circumstances, their disposal can prove to be a costly and difficult excercise. The accumulation of obsolete stocks in deteriorating containers is a matter of current concern both to the the Government of Ethiopia and donors.

3) If the pesticides are kept in unsuitable conditions, the process of deterioration is accelerated and the danger from accidental contamination increased.

Pesticide regulation

If food security is not to be purchased at the price of environmental contamination, there must be in place a system of pesticide management which conforms to the increasingly stringent standards that are being accepted internationally. The facilities and training proposed by this project will also assist in rendering existing obsolete stocks safe prior to their eventual disposal.

Each store should have the following features

1) In the event a serious accident, such as a fire, the entire contents of the store would be retained within its structure

2) All contaminated washings and waste would be retained within evaporation pans (one each for water and oil) and not be discharged into the water system

3) It would provide optimum conditions for storage of chemicals

4) It would be equipped to deal with any accident (including fire) spillage or contamination

5) It would be equipped to repack and relabel pesticides for distribution in small quantities

6) It would be equipped to repair and maintain spray equipment

7) There would be a system of management that ensures that stocks are used in rotation and not allowed to deteriorate

8) The staff would have received training in safe pesticide handling and management

II OBJECTIVES OF THE ASSISTANCE

The project would provide a reserve supply of pesticides and equipment to replace the stock expended by the armyworm control campaign of 1994.

The project would provide Ethiopia with one main intake store with a capacity of 150 tons and three strategic stores with capacities of 50 tons. They would be purpose-built to minimise wastage and environmental hazards

The project would provide training for store staff in safe and efficient pesticide handling and management

The provision of strategic stocks of pesticide and equipment in purpose-built stores would make possible the prompt control of outbreaks of migratory pests, and reduce the wastage of pesticides and hazards caused by poor storage.

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III SPECIAL CONSIDERATIONS

1) Need to ensure food security.
Food security in Ethiopia is a matter of critical concern, since large scale famine relief operations have been made necessary in recent years as a result of a series of disasters, both natural and man-made.

2) Need to reduce environmental contamination.
The storage of toxic chemical necessarily constitutes a hazard to people and the environment By providing properly designed and constructed stores and training the staff, this danger can be reduced to a minimum

IV INPUTS

1) Construction of stores
2) Training course for staff (one month)
3) Reserve stock of pesticide & equipment.

Personnel (TOR's in Annexe)

International consultant (Pesticide Management)

Equipment

See Annexe for list

REPORTING

usual

GOVERNMENT CONTRIBUTION AND SUPPORTING ARRANGEMENTS

usual

Sites for stores
Staff

PROJECT BUDGET COVERING DONOR INPUTS

Construction of stores	$600,000
One monthTraining Course	$50,000
Pesticide	$1,560,000
Equipment for spraying	$295,000
Equipment for stores	$200,000
Total	$2,705,000

TERMS OF REFERENCE

International Consultant (Pesticide Management)

The consultant will.

Conduct a one month training course for the managers and staff of the strategic pesticide stores to be constructed under the project. The training course should be carried out in a completed and fully equipped store.

The course will include the safe storage and handling of pesticide, maintenance of equipment and management of stocks to reduce wastage.

Duty Station. Addis Ababa
Duration of Mission, 1 Man-month

PESTICIDE

	rbaryl 85% wp	kg	40,000 @ $7	$280,000
I	nitrothion 50% ec	litre	60,000 @ $10	$600,000
F	nitrothion 96% ulv	litre	15,000 @ $10	$150,000
C	lorophos 24% ulv	litre	50,000 @ $10	$500,000
tc	al			$1,530,000

EQUIPMENT

For Spraying Operations

Knapsack sprayers	1,000	@ $50	$50,000
Spares for knapsack sprayers			$10,000
ULVA sprayers	4,000	@ $40	$160,000
Spares for ULVA sprayers			$25,000
Overalls	500	@ $20	$10,000
Goggles	500	@ $10	$5,000
Gloves	5000	@ $5	$25,000
Disposable masks	10,000	@ $1	$10,000
			$295,000

For Stores

Manual fork-lift for handling pallettes
Manual and electrical pumps for transferring pesticide and draining sump.
Equipment for relabelling containers
Fire extinguishers for oil fires
High pressure hose for cleaning
Protective clothing for staff.

Total for each store	$50,000
Total for four stores	$200,000

SPECIFICATION OF STORE

1) Floor space sufficient to hold 50 tons of pesticide.
2) An oil-proof sill high enough to contain the full volume of chemical stored.
3) A sloping floor with drainage and externa l sump for cleaning.
4) Adequate ventilation
5) Washing facililities and changing room for staff
6) Emergency shower with independent water reservoir
7) Appropriate fire-fighting facilities (hydrants etc).
8) Diesel and water evaporation pans to retain contaminated washings.
9) Work area for maintenance of spray equipment (draining into evaporation pan).
10) Store manager's office with separate external door.

Estimated cost of construction of main intake store	$200,000
Estimated cost of three strategic stores	$400,000

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
AFRICA BUREAU
Disaster Response Coordination
AFR/AA/DRC
Washington, D.C. 20523-0089

ENVIRONMENTAL ACTION FORM

Title of Activity: African Armyworm Control in Ethiopia.

Amendment to the Supplemental Environmental Assessment (SEA) for Locust/Grasshopper Control in Ethiopia

Country: Ethiopia

Amendment Prepared By: Gary Jahn, Consultant, AFR/AA/DRC

Date: November 1994

Recommended Action:

Approval is recommended. This Amendment to the existing SEA suffices as a self-standing document to address USAID's environmental concerns with regard to mitigation of risks due to pesticide use. Also, it adequately elucidates technical specifics unique to prospective assistance regarding the African armyworm in Ethiopia. The present Amendment is consistent with the determination reached by USAID (Appendix 2) that preparing an amendment to the existing SEA for locust and grasshopper control is an appropriate and expedient step to take. It is important to underline that once an actual intervention is contemplated in Ethiopia by USAID, the amended SEA must be linked to a specific Plan of Action developed by the appropriate implementing agency(ies).

Action Taken:

Approval: ✓ Date: 1/18/95

Disapproval: _____ Date: _____

John J. Gaudet, Ph.D.
Africa Bureau Environmental Coordinator
AFR/SD/PSGE/ENV

Review and Clearance:

AFR/SD/PSGE, Walter I. Knausenberger: WIK