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CONSORTIUM FOR INTERNATIONAL CROP PROTECTION

PEST MANAGEMENT & RELATED ENVIRONMENTAL PROTECTION PROJECT*

ANNUAL REPORT

TO

AGENCY FOR INTERNATIONAL DEVELOPMENT

OCTOBER 1983 - SEPTEMBER 1984

Ray F. Smith, University of California, Executive Director

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INTRODUCTION

The Consortium for International Crop Protection (CICP) is a non-profit, public benefit organization which was founded in August 1978 in the State of California by nine U.S. universities interested in utilizing their combined resources, talents, expertise and experience in a mutual effort to respond to the crop protection needs of the developing countries. At the present time, CICP's membership consists of fourteen institutions--thirteen universities and the United States Department of Agriculture; headquarters are located at an off-campus site near the University of California, Berkeley. CICP's basic goal is to advance economically efficient and environmentally sound crop protection practices in less developed countries. In pursuing this goal, CICP's member institutions participate in activities and projects in developing countries that encourage and support the development and adoption of integrated pest management programs and that promote the safe and effective use of pesticides in these programs.

Principal funding for the Consortium's operations is provided by the United States Agency for International Development (USAID) under terms and conditions of a general technical services contract awarded CICP in 1980 by USAID headquarters in Washington, D. C. The scope and purpose of CICP's activities are defined in this contract and make up the program known as the Pest Management and Related Environmental Protection Project. Through this project, CICP provides technical advice and assistance on pesticides and pest management to developing countries for USAID, assisting government officials, administrators, scientists, farmers, etc. in these countries in planning, developing and implementing plant pest and disease control programs which minimize human health hazards and other adverse environmental impacts. CICP has also, since 1980, provided the services of

a Regional Pest Management Specialist, located in Guatemala, following negotiation of a cooperative agreement with the Agency's Bureau for Latin America and the Caribbean.

Involvement of the Consortium in this USAID-funded project is a reaction to the modern approach to control of agricultural pests and diseases which relies, for the most part, on the application of chemicals, often with little regard for the complexities of individual crops and problems or to the dangers of environmental contamination or deleterious modification of the biosphere. Although the control of pests may often be best accomplished by the use of chemicals, it is recognized that the expertise for selecting and using these chemicals safely is usually in short supply in the developing countries. Moreover, it has been found that pesticide usage often may have severe impact upon non-target organisms such as insect natural enemies, fish, wild fowl and other forms of wildlife as well as humans. Additional problems that have arisen from the continued use of broad-spectrum chemicals are the disruption of natural controls, resurgence of pest populations, and the emergence of previously innocuous species to pest status. Also, pest resistance to pesticides through genetic selection has become a critical problem, as have problems associated with pesticide residues in agricultural products and the environment.

Notwithstanding all the varied efforts at pest control, the amount of crop losses to pest activity in the developing world is still estimated at from 20% to over 80%, depending on the country, crop and season. It is believed that adoption of improved pest management practices will permit a recovery of a significant portion of these losses and also result in greater safety for humans and an improved general environmental through the more rational use of chemical pesticides. It is the aim and purpose of the

Consortium for International Crop Protection, therefore, to assist developing countries in adopting these improved pest management systems and, towards that end, CICP is committed to the following specific goals:

- to increase and disseminate knowledge and understanding of integrated pest management and the economic, social, and educational aspects of international crop protection
- to develop and maintain an overview and current awareness of crop protection needs and problems in developing nations for the purpose of promoting the development and implementation of integrated pest management programs
- to promote coordinated interdisciplinary programs that utilize the combined expertise of the medical, nutritional, and agricultural sciences to improve the use and management of pesticides
- to initiate and cooperate in developing training programs and educational materials in crop protection and pesticide management
- to provide professional consultants to assess, evaluate, and implement specific crop protection programs, and
- to plan, conduct, and supervise research programs in crop protection and pesticide management.

The Consortium operates under the overall guidance and direction of a fourteen member Board of Directors which determines general policy, sets priorities and approves programs. Implementation of these policies, management of CICP's programs and coordination of its activities is the responsibility of an Executive Director, assisted by a small technical and administrative support staff.

This is CICP's fourth annual report and covers the period October 1, 1983 - September 30, 1984. Comments or questions about the information contained in this report may be sent to the Executive Director, Ray F. Smith.

RESPONSE TO USAID MISSION REQUESTS FOR TECHNICAL ASSISTANCE

SUDAN

NIGER

THAILAND

BOLIVIA

ECUADOR

BELIZE

CARIBBEAN

KENYA

GRENADA

MEXICO

Biological, Environmental and Human Monitoring of the Effects of Temik® Application on Cotton in the Sudan, September 10 - November 21, 1983

A technical review of the proposed use of Temik® for the control of the cotton whitefly, *Bemisia tabaci* Genn., in the Gezira and Rahad projects was conducted from July 17 - August 11, 1983 by a team of four CICP consultants. Based on a review of literature sources, interviews with various Sudanese officials and technical personnel and several on-site visits, the team prepared a 55-page report which evaluated the development of integrated pest management on cotton in the Gezira and discussed in particular detail the proposed use of Temik® for the control of the cotton whitefly. (A summary of the findings and recommendations made by these four individuals was presented in a report of CICP's 1982-1983 activities). In order to allay the concern of Sudanese and other involved officials regarding the potential effects on human and animal health and upon the environment from the scheduled use of Temik® on 160,000 feddans of cotton in the Gezira during the 1983-84 growing season, a detailed plan for monitoring the movement of this chemical in the environment was presented in the report.

The plan recommended that a three-person health and environmental team and a two-man biological monitoring team undertake the studies needed to determine the fate of the residues of this pesticide in the environment. This recommendation was accepted by the USAID Mission in Khartoum which then requested CICP to provide the necessary personnel to conduct these studies. The individuals selected for these teams were Geoffrey W. Zehnder, postdoctoral fellow in entomology, University of California, Riverside; J. Hodge Black, cotton extension specialist, University of California Cooperative Extension, Bakersfield (biological monitoring team);

Joseph Danauskas, field epidemiologist; J. Bruce Mann, chemist, both at the University of Miami, School of Medicine, Miami, Florida; and Donald P. Morgan, M.D., Institute of Agricultural Medicine, University of Iowa, Oakdale (human and environmental monitoring team). The latter team was also assisted by Hale Vandermer, U. S. Environmental Protection Agency, Washington, D.C., in analysis of the results and writing of their report. The two teams were to conduct studies intended to assess the risk of poisoning to loaders and applicators and residents of the Gezira by the use of a highly toxic pesticide, 15% encapsulated Temik® granules, and to monitor the effects of Temik® on the pest and beneficial fauna in the cotton ecosystem. Other objectives of the teams were to evaluate the adequacy of local medical facilities for recognizing, treating, and reporting pesticide poisoning cases and to conduct a plant growth analysis that would chart the effect of Temik® on the cotton plant's growth and fruiting.

Biological Monitoring. The biological monitoring team arrived in the Sudan on September 10, 1983 and conducted on-site monitoring of treated and untreated cotton fields from the beginning of Temik® applications on September 24 until November 15. The sampling procedures used were adopted in part from the Sudan Gezira Board's sampling protocol in order to facilitate comparison of this study with other data that might be obtained by that organization in the future. Different methods of sampling - whole plant, leaf and sweep-net - were used to determine the abundance of a pest or beneficial insect depending on the biological habits of the particular species involved. Selection of the field sites for sampling was made from fields located in the areas known as South and Centre sections. Three fields in each section were sampled.

In their discussion of the results obtained, Zehnder and Black stressed that the data collected were not from replicated trials and therefore should not be construed as being experimental results. They also emphasized that the effect of Temik® alone on the insect complex in cotton could not be evaluated because all the fields received aerial spray applications of other pesticides. However, as whitefly populations did not appear to be obviously affected by the chemicals most commonly used, they considered that the data obtained in their study should give a good indication of Temik's® effect on this pest species.

The sampling results of the monitoring team, as well as those obtained by Sudan Gezira Board entomologists, indicated high whitefly populations in the Gezira during the 1983 season. At least a few whitefly adults were found on almost all plants sampled, even in fields where Temik® had recently been irrigated into the soil, although density of the whitefly population was 2-3 times lower in treated fields than in those where Temik® had not been applied or where application had been delayed. In treated fields, whitefly populations were not eliminated but were sufficiently reduced to prevent honeydew contamination of cotton lint. In contrast, copious honeydew production was observed on cotton which had not been treated with this chemical.

The results of their monitoring efforts of the abundance of other insect species showed that the density of the jassid, Empoasca lybica de Berg., was low in all the areas sampled. Infestations of the American bollworm, Heliothis armigera (Hubner), occurred in a few isolated locations but were effectively controlled by aerial spray applications of other pesticides. Several beneficial insect predator species, such as Chrysopa sp., Orius sp., and coccinellids, were collected in sweep-net samples, but

their numbers were reduced following aerial applications. Parasites of the whitefly in the genus Eretmocerus were found only in the untreated portion of a field in the Centre section where whitefly density was extremely high. The team reported that they were not able to determine whether Temik® had any effect on plant growth or fruiting rate of the cotton plant because of the variation in planting dates, irrigation and fertilization rates in the fields sampled.

In their report, the biological monitoring team stated their belief that the economic threshold for the American bollworm established by the Sudan Gezira Board had been set too low, resulting in excessive early applications of broad spectrum insecticides that may have contributed to the severity of whitefly infestations and that of other pests. Based upon their data, they believed that virtually all aerial applications made during the period fields were monitored were not justified. In their concluding remarks, the team stated that Temik® did appear to be effective in reducing whitefly populations below levels at which honeydew contamination occurs, but that the establishment of a permanent solution to the whitefly problem in the Sudan would depend in large part on the more judicious use of broad spectrum pesticides.

Human and Environmental Monitoring. The team that was to conduct the human and environmental monitoring also arrived in the Sudan on September 10, but due to a delay in arrival of shipments of medical supplies, sample bottles, and other supplies, actual sampling did not begin until the first week of October and ended on October 29. The objective of the monitoring program was to evaluate the likelihood of poisoning of loaders and applicators and residents of the Gezira as a result of their direct or incidental exposure to a highly toxic pesticide, Temik®. This aim was pursued by

using several methods of inquiry that included an examination of the physical circumstances of the work environment for loaders and applicators and a physical examination of loaders and applicators before and after they handled Temik®. This latter examination involved making inquiries about the occurrence of symptoms, such as nausea, weakness, dizziness or abdominal pain, and observation of signs of poisoning, i.e. gait, pupil size, tremors and hand strength, as well as taking actual specimens of urine and blood.

The design of the monitoring program was intended, within the limits of time and resources available, to assess the amounts and levels of human and environmental exposure to the carbamate pesticide, Temik®, as a result of its application on cotton. In their report, the team expressed the view that this assessment should be regarded as a comprehensive survey of various routes of exposure and not as a systematic and thorough investigation of single exposure routes. The intent was to document, record, analyze and clinically support and identify areas of concern involving the procedures and operations used in the handling and application of Temik®, even though they realized it would not be a perfect statistical study. The team was assisted in this monitoring program by trained Sudanese personnel who were involved in field sampling and routine blood cholinesterase analyses as well as other aspects of the study.

During the month of October, the monitoring team obtained a total of 523 samples from the following substrates: air, soil, water, vegetables, cotton plants, house dust and dirt, cloth patches and human blood and urine. Samples taken from human subjects comprised 80% of all those obtained in the study. The team originally intended to conduct a systematic sampling of the worker population by examining 25 applicators and 25

loaders and collecting urine samples before and after they were exposed to Temik® for evidence of toxicity; however, this proved to be impossible because of logistical problems and only 10 true before and after urine samples were actually obtained from tractor drivers (applicators) while 10 paired samples were secured from loaders. Single urine samples were also collected from tenant farmers and the general population.

Monitoring of acetylcholinesterase levels in the blood was conducted on tractor drivers, loaders, inspectors, supervisors, tenant farmers and the general population. Finger-prick blood samples were taken from 38 individuals and analyzed on-site by the team using the Acholest test kit. Blood samples were also obtained from nearly 50 individuals and sent to the University of Miami laboratory in Florida for analysis by the modified Michel method. The blood samples were collected in clean heparinized containers and immediately placed in ice to preserve them while in transit to the United States. The samples were shipped frozen to prevent further metabolism of the pesticide and to facilitate entry into the U. S. under conditions of the team's import permit. Dry ice, which had been shipped from London to the Sudan, was added to these samples at the airport to keep them frozen en route.

The Sudanese technicians participating in this investigation were trained before they began the field evaluations of Temik® exposure. The training they received involved (1) administration of the Acholest test for acetylcholinesterase determination; (2) the methods for collecting urine samples; (3) soil sampling; (4) water sampling; (5) use of personal air samplers and high volume air samplers; and (6) the placement of gauze patches on the body. Six high volume air samples were taken from four tenant farmers' homes while personal air samplers were placed on two

loaders and two tractor drivers to measure the amount of inhalation exposure at loading areas, in treated fields, and at the tenant farmers' compound. Eight gauze patches were placed on the clothing of each of seven exposed individuals to determine the amount of their contact with the chemical. By relating the patch area to the total body surface, it was possible to calculate the potential dermal exposure of the worker.

Soil samples were taken both at the mixing/loading area in the treated fields and at the tenant farmers' compound. The Union Carbide Agriculture Products Company, Inc. also took soil samples and did soil degradation studies in the same areas where the human monitoring was being conducted by the CICP team. The latter also obtained house dust and dirt from the living quarters of four tenant farm workers. Water samples were obtained from a number of sites, but especially those which were the source of drinking water for the tenant farmers. Nineteen samples of vegetables from the garden plots of four tenant farmers were taken for residue analysis. Leafy vegetables such as collards, lettuce, spinach and kale were sampled in addition to onions, tomatoes, okra and snap beans. All vegetables were collected between 7 and 14 days after the Temik® application and several days after the cotton field was irrigated. Where possible, samples were taken from crops that were at or near harvest.

Analyses of the various samples obtained were performed on a Tracor 222 and Micro Tek 220 gas chromatograph utilizing methodology that had been developed by Union Carbide. All methods were similar in that the aldicarb, aldicarb sulfoxide and aldicarb sulfone were oxidized with peracetic acid to ensure the presence of only the aldicarb sulfone, which was then analyzed Results of the personal air samples taken from two tractor drivers and two loaders revealed that Temik was present in the air, up to a level

of 1.69 mg/m^3. Further evidence of their exposure to this chemical was provided by the analysis of gauze patches that had been placed on their clothing which on a pooled basis yielded between 19.4 - 70.6 ppb Temik®. Urine samples were also taken from these individuals which upon analysis gave levels from 2-43 ppb.

Analysis of the dust and dirt samples taken from the homes of tenant farmers failed to detect residues of Temik® at the limits of detection of the University of Miami laboratory. This laboratory also failed to find residues in a single soil sample obtained from a site where the used containers of Temik® were burned after loading although the Union Carbide laboratory found small levels of residue present. Neither laboratory was able to detect the presence of Temik® residues in any of the water samples.

All of the garden vegetable samples were split and analyzed by both the University of Miami and Union Carbide laboratories. The former did not detect the presence of Temik in any of the plant material analyzed while the Union Carbide laboratory generally reported the presence of residues below their levels of quantification, less than 0.01 ppm. However, quantifiable amounts of aldicarb sulfone residue were detected by this laboratory in dura and an unnamed edible garden green at 0.06 ppm and 0.05 ppm, respectively. Both laboratories were able to detect and quantify levels of aldicarb sulfone in cotton plants and foliage at concentrations that ranged from 0.048 to 8.3 ppm.

The results of the analyses of blood samples revealed that while there were some plasma cholinesterase values which were at the low normal or borderline depression level in the 82 individuals tested, none of these would be considered clearly depressed based on a normal range of 0.45 to 1.25 pH/hr. The lowest value obtained from the 35 subjects in the

general population group was 0.53; the lowest value from those in the loader group was 0.49 and the lowest value among those in the applicator category was 0.52. None of these values by themselves would be indicative of acetylcholinesterase depression or subsequent acute toxic poisoning by a carbamate pesticide although the team's report noted that it was important to remember that depression of acetylcholinesterase levels resulting from carbamate poisoning is quickly reversible.

Measurement of Temik® residues in the urine was the most extensive part of this human and environmental monitoring study. Samples were obtained from two groups of workers occupationally exposed to this pesticide as well as from a third group of individuals selected at random from the hospital at Wad Medani. This latter group included outpatients and employees of the hospital who were selected on the basis that they had no previous occupational exposure to Temik®. Samples of urine were obtained from the applicators and loaders in the morning before they began to work and, as often as possible, an afternoon sample was collected from the same individuals after their day's work had been completed. Only single morning samples were obtained from those individuals in the general population who were not expected to have been exposed to Temik®.

The results of the analyses of these samples showed that loaders had the highest levels of Temik® residue in their urine of the three groups. The average level of residue found in this group's morning sample was 22.85 ppb while in the afternoon the average had increased to 48.35 ppb. The corresponding figures for the applicators, or tractor drivers, were 11.72 ppb and 24.77 ppb for morning and afternoon, respectively. The team in their report stated that their data suggested the existence of a state of equilibrium wherein the amount of Temik® absorbed during the worker's daily

exposure was excreted overnight prior to the beginning of the next day's exposure. They felt this explanation was consistent with the chemistry of this pesticide which is quickly metabolized in the body to the free enzyme and carbamic acid and subsequently excreted. Although the data obtained from the loader group seemed to verify their suggestion, the data provided by the tractor driver group was less convincing.

The team's report also stated that their data indicated that exposure to this pesticide was not simply an occupational hazard, but that it could occur within the general population as well, citing a mean residue level of 4.24 ppb aldicarb sulfone in this group in substantiation of their statement. While this residue level was much lower than in the other two groups, the report stressed that it nevertheless signaled the need for continued monitoring of the situation.

Based on the residue values of aldicarb sulfone present in humans sampled in this study, the monitoring team made an initial estimate of the relative risk to humans from poisoning by Temik®. This estimate was derived from the published No Adverse Effect Dose (NAED) figure of 0.125 mg/kg of body weight which had previously been established for this chemical in humans. Utilizing the highest sulfone residue value obtained during this study of 271 ug/liter of urine, an assumption of 70 kg body weight for the individual involved and the knowledge from other studies that about 10% of the exposure dose appears in the urine within 8 hours of exposure, the team calculated that even in the highest exposure situation there appeared to be a three-fold factor between the level of residue obtained and the NAED level. Actually, as the mean urine residue level obtained in this study was 31 ppb, the average exposed worker received only 3.54 % of the dose necessary to exceed the NAED level and cause an adverse effect.

In view of the data collected and observations made during the 1983 season of Temik® applications, the CICP monitoring team expressed the view that it appeared there was little likelihood of an occupational exposure reaching or exceeding the established No Adverse Effect Dose in persons engaged in the occupations studied as well as there being little chance for this to occur in the general population. However, they believed the possibility of additional exposure in the home, through the food chain, or in the drinking water was not excluded. Furthermore, they cautioned that the toxicological effects in humans from a chronic low dose exposure to this chemical was an area for further investigation and research and most certainly needed to be monitored if the use of Temik® was going to be continued in the Sudan.

Despite the toxicity of this material, the team noted the following features of the application process that would seem to mitigate hazard to persons handling the pesticide and to local residents:

(1) the aldicarb-treated granular material is encapsulated so that dust from filling of hoppers is virtually absent and unlikely to pose a hazard to loaders or applicators,

(2) the pesticide is applied by ground equipment, thus reducing drift,

(3) the pesticide is packaged in durable boxes that are relatively easy to open and which allows transfer into hoppers without spillage or contact with skin, and

(4) the use of this chemical is claimed to eliminate 3-4 aerial applications of other pesticides.

In opposition to the foregoing, the team found there were several factors operating in the Gezira which enhanced the risk of human injury by Temik® or other highly toxic materials:

(1) the Gezira itself is a large expanse of land area with poor roads and inadequate communication systems,

(2) travel is possible only by way of badly rutted dirt roads,

(3) the only medical facilities where poisonings might be treated are at small hospital-clinics in the Gezira, yet practitioners are totally inexperienced in recognizing and treating poisoning of any kind,

(4) Temik® loading and application are carried out at base stations remote from these medical facilities, and

(5) at most of these stations, no communications and no motorized vehicles, except fuel trucks and tractors, are regularly available.

Because of these factors, the team felt that the likelihood of survival of a severely poisoned individual would seem to be very slim and, therefore, they believed that prompt and adequate treatment of poisoning cannot be counted on as a factor mitigating the hazard of pesticide use in the Gezira. Consequently, it was their opinion that the only substantive approach to limiting the hazard of poisoning is prevention. This approach had been adopted by the Union Carbide Agriculture Products Company, Inc., and the team noted the strenuous efforts made by this firm to promote the safe handling of pesticides - safety training sessions in Arabic had been presented to tractor drivers, loaders and supervisors; warning labels and posters were displayed almost everywhere in the work environment; workers were provided with dust masks and disposable gloves and given detailed instructions on how to deal with accidental spills and how to recognize the early signs of poisoning; radio and TV programs were sponsored in which

Gezira residents were warned not to allow livestock to eat cotton plants or drink from flooded furrows following Temik® application; and residents were also warned to stay out of fields during and after Temik® application until the irrigation water soaked into the ground and the soil dried. USAID personnel commended the efforts of Union Carbide to try to minimize the environmental and health hazards associated with Temik® use in the Sudan although the intensity of the safety campaign caused some workers and residents to express fears that Temik® must have some sinister effects that had not been explained to them.

In summary, the CICP monitoring team concluded that, on balance, the 1983 application of Temik® in the Gezira was conducted in a safe and effective manner. They recommended continuous monitoring of all pesticides used in the region, including Temik®, for both public health and agricultural purposes. They did not find any evidence which would indicate the need to abandon any plans for the future use of Temik® on cotton in the Gezira as long as the dose per acre did not exceed two pounds of active ingredient as in 1983, and future applications and use of the material are carried out with equal or better regard to human safety and preservation of the environment. The team also recommended the incorporation of integrated pest management into public health vector control and agricultural production programs to assure a greater measure of freedom from toxic material exposure and improved pest control. Finally, they stated that future use of Temik® in the Gezira should continue only if it is carefully monitored in terms of safety to the general population, the work force, and the environment.

Technical Assistance on Crop Protection for the Niamey Department Project, Niger, September 19 - October 18, 1983

The Niamey Department Development (NDD) Project is an USAID supported integrated rural development effort for teaching farm families in Niger improved agricultural techniques at residential training centers. CICP consultants have provided technical assistance on crop protection to this project since 1980 and, in the present instance, CICP crop protection specialist, Patricia C. Matteson, visited Niger to review changing pesticide use patterns in the project, assist in the prioritization of crop protection research being conducted by the project's applied research specialist and make recommendations about what pesticide experiments should be undertaken by the NDD project in future cropping seasons.

As specified in the Project Paper, the applied research specialist tested synthetic pyrethroid insecticides for routine spraying of cowpea after flowering; however, Dr. Matteson believed that there was not enough data available from these experiments to determine which pesticide used was most economic. She also felt there was not enough information even to decide whether or not the spraying recommendation itself should be retained. In her opinion, results of experiments to that time indicated that routine spraying of cowpea may not be economic, at least in drier parts of the project zone. For that reason, and also because farmers in Niger simply do not plant monocropped cowpea, she believed that the technical recommendation of planting cowpea in a monoculture which requires insecticide protection may have to be reconsidered in the future.

After reviewing various aspects of the project's program of applied pesticide research, Matteson stated that when the results from the 1983

pesticide trials on cowpea were known, all the data to date should be reviewed by project personnel and consultants and, if the accumulated data clearly showed that routine spraying of cowpea was uneconomic in all or part of the project zone, then the technical recommendation for this spraying should be discontinued by the project. If further experimentation was necessary, she advised the applied research specialist to seek assistance from USAID consultants or other outside experts; if no assistance was obtainable, then the specialist should continue the work alone on a reduced scale or temporarily drop this pesticide research in favor of more pressing work. She found that the Plant Protection Service would not be able to continue pesticide research on cowpeas because the individual primarily responsible for this research was too burdened with administrative duties to perform this work. Without continuing assistance from this service and the German Agency for Technical Cooperation (GTZ), or from other outside sources, Matteson believed that the NDD project could not continue to do pesticide research on this crop on the present scale. She emphatically stressed, however, that any recommendation for pesticides must be proven effective and economic before credit is extended for farmer purchase of pesticides and sprayers.

Concerning the use of pesticides for seed treatment, she stated that since Thioral cannot be used in USAID projects because it contains heptachlor, a pesticide which is no longer registered in the U.S. because of human health hazards and its persistence in the environment, then a stand establishment trial was needed to compare it with thiram, an insect-repelling fungicide, to evaluate the latter's potential usefulness as a seed treatment. She recommended that the applied research specialist carry out a thiram vs. Thioral stand establishment trial for two years to

determine whether the former would be a suitable pesticide to replace Thioral. If the trials indicated that thiram was not suitable, then she suggested that the project purchase fungicide/ insecticide combinations that could be used under USAID environmental regulations and test these materials also as possible nationwide replacements for Thioral.

Matteson noted that purchase of pesticides by the NDD project was a temporary measure taken in order to comply with USAID environmental regulations and that the Plant Protection Service had changed the spectrum of insecticides made available for field interventions in Niamey Department and elsewhere in Niger. She observed that the new chemicals provided by the Service almost certainly have the FAO/WHO tolerances necessary to cover NDD project use patterns in accordance with USAID environmental regulations and that the latter probably no longer require the project to purchase its own pesticides for use on field crops. However, she specified that the project must continue to buy and use its own seed treatment pesticides until the Niger government supplies chemicals for this purpose that are admissible under USAID environmental regulations. She also added that she must confirm that chemicals presently used by the Plant Protection Service can be used by the NDD project in accordance with USAID regulations and, if so, she must write an amendment to the project's Initial Environmental Examination authorizing their use.

In summary, Matteson found that the NDD project had complied satisfactorily with the guidelines relating to pesticide use and applied pesticides research that were specified in the Environmental Annex to the Phase II Project Paper, and she believed that the experimental results obtained from the applied research that was being carried out to test

technical recommendations would be useful to other USAID agricultural projects in the Sahel.

Environmental Assessment of Pesticide Use in the Northeast Rainfed Agricultural Development Project, Thailand, October 1-24, 1983

The purpose of this project was to develop a multifaceted farming systems approach which would interact with the various departments in the Ministry of Agriculture and Cooperatives to strengthen and stimulate research and extension activities most relevant to the improvement of farming systems within the rainfed agricultural regions of northeastern Thailand. This approach was to be replicated in nine representative areas in the northeast in an attempt to stabilize and improve subsistence farm production and increase the economic well-being of the poor farmers of the region. Project activities were to be implemented by three working groups with responsibilities in the area of cropping systems, water resources and common lands development and with overall integration and coordination under the direction of a separate farming systems working group. Particular components of the project included the training of villagers in the basic principles of poultry production, introduction of techniques to improve disease and parasite control in large animals, training of farmers to improve fish production in both project constructed and existing reservoirs, strengthening of sericulture activities in local villages by introduction of hybrid silkworms capable of greater fiber production, and improvement of cultural practices to increase the supply of mulberry leaves for these worms.

Activities of the cropping systems component were directed toward increasing the agricultural productivity of the region by encouraging more

intensive rice based cropping patterns and introducing legumes and other cash crops. Associated with these alterations in cropping patterns were to be attempts to implement and facilitate various agronomic inputs such as increased small scale irrigation systems, use of improved varieties and increased utilization of fertilizer and pesticides. As greater inputs of pesticides posed potential hazards to the environment, it was determined that an environmental assessment of the possible impact of increased levels of pesticide use should be conducted. The individual selected to perform this assessment was W. Harvey Reissig, entomologist, Cornell University, and the following account is based on information in his report.

The project area is located in the northeastern part of the country in a region known as the Korat Plateau. This region encompasses about one-third of the country's total land area and has one-third of the population. The soil is generally sandy and infertile, with a low water-holding capacity. Agricultural productivity is generally low throughout the region because of unreliable rainfall which produces crop losses from flooding or drought. Rice is the staple food crop on the plateau and is grown on about 53% of the total cultivated land. Cassava is the next most important crop occupying about 36% of the land while kenaf and vegetables are cultivated on 4% and 5% of the land, respectively. Overall production and yields of rice have grown steadily, albeit erratically, over the past 15 years with most of the instability attributed to variations in rainfall patterns.

In assessing project needs, Reissig proposed the use of sixteen pesticides for the initial cropping systems trials on rice, maize, mung bean, vegetables, peanuts, soybeans and kenaf. The criteria he used in selecting these pesticides were their availability, relatively low toxicity and effectiveness and a determination that they had appropriate crop

residue tolerances established by EPA or FAO. All of the selected materials were being widely used on a variety of crops in the United States and, in addition, had been tested by personnel in Thailand and were being recommended for use on the crops listed above. With the exception of carbofuran and monocrotophos, all of these pesticides are classified as only moderately or slightly hazardous by the World Health Organization, based on their toxicity to humans. In his report, Reissig stated that carbofuran granules would not be applied in rice fields primarily involved in fish culture, or in fields in which runoff water would be likely to contaminate streams, rivers or ponds. A further limitation on this pesticide's use in the project was imposed by his declaration that this material would be applied only by farmers under the supervision of project technicians who were to insure that the farmers were trained in pesticide safety and would wear the proper protective clothing.

The same restrictive conditions regarding application were also imposed on the use of monocrotophos. This pesticide was the only chemical classified for restricted use by the U.S. Environmental Protection Agency which was selected for use in this project. It was not to be used on rice because it could be hazardous to applicators and fish and other aquatic organisms under the flooded conditions prevalent in most fields. It was also considered too toxic to be recommended for general use within the project and was to be applied only on soybeans, mung beans, maize and vegetables, crops which are usually grown under drier conditions where watersheds would not become contaminated.

In discussing the extent to which the proposed pesticides would be part of an integrated pest management program, Reissig recommended that an IPM Coordinating Committee be established to review the available crop

protection technology and research in Thailand and other tropical countries in Southeast Asia in order to develop an appropriate IPM program for the cropping systems activities within the project. This committee was to consist of representatives from the Department of Agriculture, Department of Agricultural Extension and the Northeast Regional Office of Agriculture, and other institutions as necessary, and was to integrate some of the following IPM components into the proposed control program for each important crop within the cropping systems trials and demonstrations:

(1) trials to determine the most effective timing, method of application and appropriate pesticide for control of the entire pest complex attacking the crop,

(2) the use and selection of improved varieties or cultivars which are resistant to pests, most suitable for local farmers and adapted to local agroecosystem,

(3) the identification and use of indigenous parasites and predators of insect pests,

(4) studies on the effects of various cultural and agronomic practices on the incidence and severity of various pests,

(5) determination of the most effective practical sampling and monitoring techniques for each pest, and

(6) estimation of economic injury levels and cost-benefit analysis of various control programs.

Ultimately, Reissig felt that the committee should attempt to integrate the IPM programs for each individual crop into a complete package for the major cropping systems patterns evaluated in the project area.

In his report, Reissig considered a number of actions to mitigate the risks involved with the expected increased use of pesticides. Among these

actions was the presentation of training courses in pesticide management for project personnel, extension agents and farmers cooperating in cropping systems trials. These courses were to include basic information about toxicology and environmental hazards, safe handling and application, and pesticide storage and disposal. Farmers were also to be trained to minimize their exposure to pesticides during mixing procedures and would be advised to wear protective clothing while applying pesticides. The project would purchase safety equipment, such as face masks, rubber gloves and boots, etc., and would loan it to farmers or technicians making pesticide applications. All pesticides purchased by the project were to be stored in pesticide storage sheds located throughout the project area. These facilities were to be separated from office space or human dwellings, locked, posted with a warning sign and provided with adequate outside ventilation. In addition, special soil disposal pits were to be constructed within the project area to handle pesticide wastes or empty containers. In order to insure that pesticides would not pose major hazards to aquatic environments or water sources, he recommended the initiation of a program to monitor pesticide residues in ground or surface water in watersheds that may be contaminated by the secondary transportation of pesticides from areas of application or from flooded paddies in which the water is directly contaminated by improper pesticide application. He also recommended a program to monitor pesticide residues at harvest on crops such as vegetables which are treated with relatively high levels of pesticide. This program would insure that pesticides were being applied in accordance with recommended procedures and would protect the health of consumers.

Finally, in addition to the proposed plans for project personnel to work with selected farmers participating in cropping systems trials,

Reissig felt it would be desirable in the future to implement a larger scale pilot IPM program within the project area in a single village or several selected villages in different provinces. In this way, the IPM practices and farmer training programs developed and tested during the initial cropping systems activities of the project could be evaluated and implemented more widely in the agricultural areas of the northeast.

Environmental Assessment for Proposed Pesticide Use in Disaster Recovery Project, Bolivia, December 5-22, 1983

The funding of a ten-million-dollar amendment to this project for the purchase of agricultural inputs, including pesticides, was proposed by USAID as a short-term response to the needs of the country for these essential materials following the effects of a prolonged drought in the highlands (Altiplano) and flooding in the southeastern part of the country. Since these funds would be used for the purchase of pesticides, an assessment of the anticipated impacts of these pesticides on humans and the environment was necessary to assure that their use would comply with established USAID policies, regulations, and environmental procedures. The individuals selected to conduct this assessment were Carroll Collier, pest management specialist, USAID, Washington, D.C. and Donald J. Calvert, CICP crop protection specialist.

In their report, the two men discussed the situation which existed in Bolivia with regard to pesticide use by small farmers and referred to an earlier CICP publication, written in 1979, which described the circumstances attending this use, citing a general ignorance and neglect of safety precautions in the handling and use of pesticides, a high disregard for the toxicity of these materials among the persons responsible for their

use, inadvertent poisonings, deaths from intoxication, and excessive applications of pesticides -- conditions which they found had not changed during the intervening period. Reviewing the kinds of insecticides currently being recommended for use in the country by government agricultural experiment stations, they noted that most of these chemicals were either too highly toxic to be acceptable under USAID regulations, or they were chlorinated hydrocarbon compounds that had been banned for use in agricultural crops in most developed countries based on their persistent and bioaccumulative properties.

In view of the necessity of proposing alternatives to these toxic chemicals, Collier and Calvert prepared a list of over 40 pesticides they considered suitable for general use by small farmers in Bolivia. Among the factors they considered in selecting these chemicals were the following: acute toxicity and long-term toxicological hazards, efficacy for the use intended, the USEPA registration status of the proposed pesticides, conditions under which the pesticides were to be used, possible adverse effects of the pesticide on beneficial parasites and predators, likelihood of the early onset of pest resistance with continued use, etc. More specifically, chemicals on their list were chosen because they were considered relatively safe, even for use by small farmers that have had minimal or no exposure to pesticide safety training. Hence, all of these pesticides are registered in the United States for general use, without restriction, except for propineb, which is registered in the Federal Republic of Germany and has been scientifically evaluated by the Joint FAO/WHO Committee on Pesticide Residues. In addition to safety criteria, selection of these pesticides was made based on a careful review of several locally available research and extension documents and on interviews with crop protection researchers,

extension agents, farmers, officials from farm cooperatives, and pesticide sales agents.

Collier and Calvert also reviewed Bolivia's ability to regulate or control the distribution, storage, use, and disposal of the pesticides that will be purchased and reported that, although it has adequate legislation to allow for strict regulation of pesticides in terms of registration, importation, sale, and control of use, there was virtually no implementation of the law, and small farmers could buy any pesticide available in the local stores, regardless of its toxicity. Furthermore, there seemed to be an emphasis placed in their marketing on low-cost pesticide products with total disregard for farmer safety. Consequently, in their report the two men introduced to the maximum extent possible a variety of relatively safe chemicals as replacements for the more highly toxic pesticides in common use. In addition, they proposed a number of initiatives designed to provide improved pest control as well as to reduce the hazard to humans and the environment from the use of pesticides.

The actions proposed included the following:

1) an integrated pest management research program to collect and assess background data on pest management problems in potatoes and to conduct small field trials with different pesticides to establish which ones, if any, are justified from a cost-effective pest management approach. The expected result of this program was the provision of a framework upon which a larger and more ambitious IPM program could be built,

2) the presentation of a series of three-day workshops in the safe and efficient use of pesticides intended for persons who deal directly with them, such as farmers, pesticide applicators, formulators, extension agents, etc.,

3) a small-scale monitoring program of plants, soil, and water in the research area to obtain baseline information on residue levels of the pesticides used in order to ensure and protect the safety of humans from the consequences of their use. The acquisition of such information was also judged essential and necessary to provide an objective basis for evaluating the problem, to ensure general compliance with standards established by a regulatory agency, to provide support for a program of enforcement and to serve as a model for a more extensive, long-term study,

4) the attendance of two individuals from MACA's pesticide residue analytical laboratory at a six-week course on methods of residue analysis presented by the University of Miami in Florida, and

5) a review of three pesticide repackaging facilities located in Santa Cruz, La Paz and Sucre, respectively, to define and suggest appropriate safety practices and waste disposal methods as well as provide advice on package specifications, relabelling and purchase of containers and filling machinery.

Planning for Pesticide Management and Integrated Pest Management Training in Ecuador, January 8-19, 1984

In response to a request from USAID officials in Ecuador, CICP asked Consultant James Grieshop to meet with representatives from the Instituto Nacional de Investigaciones Agropecuarias (INIAP), the Consejo Nacional de Ciencia y Tecnología (CONACYT) and Programa Nacional de Sanidad Vegetal (PNSV) in Quito to discuss future plans for short- and long-term training in crop protection and pesticide management in Ecuador. These individuals joined Dr. Grieshop and USAID/Quito personnel at the Ministry of Agriculture (MAG) to diagnose and analyze problems and to develop plans and

recommendations. Important concerns identified in the initial meetings were (1) whether a program could be carried out to completion, and (2) whether there could be financial support for the organizations, as well as for necessary travel and subsistence for the individual members.

A study team, composed of two representatives each from INIAP, PNSV and CONACYT, was organized and given the task of working closely with Grieshop during the ten-day period of his stay in Ecuador.

Study visits were made to the four major experiment stations in Ecuador: Tumbaco, Santa Catalina, Pichilingue and Santo Domingo. Assets and limitations at each station were studied. Problems common to all included poor relationships between the private sector and the station personnel; limited opportunity for researchers from different stations to meet together for their mutual benefit due to lack of funds; low level of resources available, including transportation; inadequate support for personnel, especially for university students working on their theses where some important work could be accomplished.

A number of talented and dedicated personnel in the fields of plant pathology, entomology, residue analysis and quality control, and other related areas were employed at the Tumbaco Experiment Station, but they were unable to function well because of inadequate support. Some station facilities appeared to be available for conferences. The director of the pesticide residues laboratory was working on plans for a conference related to new pesticide regulations, and Grieshop assisted in determining objectives, audience and other elements for this event.

Personnel at the Santa Catalina INIAP Station represented disciplines of entomology, nematology, plant pathology, and pesticide residue analysis, and were also strongly motivated but limited by few resources. At the time

of the visit, several sections of the station had not had electricity for two months due to transformer problems, and work was at a standstill. The Department of Communications and Public Relations at the station has responsibility for technical, audio-visual and public relations activities, and provides audio-visual materials used by students as well as others. This center is the primary source of publication of INIAP materials, and the printing plant appeared to be adequate, but without electricity was inactive. The study noted that this center could be expanded in terms of its functions.

At Pichilingue Station, Dr. Grieshop met with the national coordinator of the Programa de Investigaciones en Produccion (PIP) to discuss its work with INIAP and Desarrollo Rural Integrado (DRI). PIP works in eleven geographical zones with a coordinator in each and a total of 26 professionals performing extension functions. The director of the Pichilingue Experiment Station showed great interest in moving ahead on programs in pesticide management, and indicated an urgent need for a training course with vendors and farmers in the Asociación de Productores del Ciclo Corto (APROCICO). She emphasized the need for posters and published materials to be distributed throughout the zone in churches, schools, and community centers. Pesticide vendors promote the use of pesticides and are apparently over-represented in each geographical zone, whereas extension personnel call for less use of these chemicals but have much larger areas of responsibility with fewer personnel, limiting their visits. She stressed the need for better understanding of safety on the part of the vendors, to avoid such problems as selling pesticides alongside of flour in the small pharmacies and grocery stores. Later interviews with persons doing research on land tenure revealed that, because of the economic need of the

peasants, insecticides and fungicides are used liberally to ensure good production.

The availability of dormitories and restaurants makes Pichilingue an ideal site for a suggested two-day conference with vendors and growers to begin focusing on the issues of pesticide resistance and biological control, as well as for other conferences in the future.

The important group of growers at the Santo Domingo Station is known as the Asociación de Cultivadores de Palma Africana (ANCUPA). There is heavy reliance on use of pesticides, and while individual growers occasionally come to that station for help, they do not provide assistance back to the station. At the time of the study team visit, plans were developing for a series of conferences with ANCUPA members on pesticides, biological control and other areas. It was discovered that one section of the laboratories had been without water for some time, making any productive activity impossible.

Grieshop met with the Director and other personnel at the Fundación Natura in Quito to discuss possible roles of the Fundación. This organization sees its role as strictly educational and hopes to introduce an environmental education curriculum in the schools throughout the country. They collaborate closely with INIAP personnel on technical material to be published.

Following these visits and an extensive consultation with the interested groups, CICP Consultant Grieshop worked with AID/Quito personnel in developing preliminary sketches of a proposed plan for a national system of pesticide management and integrated pest management in Ecuador. A plan for a commission to develop a national plan for IPM was laid out. The commission, as agreed by the study team members, would include entomolo-

gists, nematologists, plant pathologists, chemists, probably an ecologist and possibly a medical person for the purpose of diagnosis, although participation of this latter individual might be premature at this time.

The Peace Corps Program Training Officer showed great interest in the program and indicated that the issue of misuse of pesticides is one of the most significant problems facing agricultural volunteers, and that if safety training or other pertinent training were offered, the Peace Corps would be able to participate at its own expense. He also indicated that there is presently no well-thought-out strategy for involving Peace Corps members in extension work, and recommended some analytical studies on this relationship.

The study team members, including a representative from Fundación Natura, met in special sessions with Grieshop and AID personnel to develop components for the plan. The final draft of the Development Plan for Systems of Pesticide Management and Integrated Pest Management in Ecuador, with related budgetary recommendations, was completed and submitted to USAID/Washington, as originally requested.

Assessment of Production Problems in Cantaloupe, Belize,
February 7-12, 1984

Responding to the concerns of farmers about a decline in the production of cantaloupes, USAID requested CICP to arrange for a consultant to visit Belize and assess the situation. The individual selected for this assignment was Gary W. Simone, plant pathologist, University of Florida. At the time of his arrival in Belize, the problems in this crop had been defined by specialists at Texas A&M University, after they had had an opportunity to examine plant samples sent to Texas, as 1) small fruit size

(below market grade), and 2) scorched vines. The reason for the smaller melons had been attributed to cooler than normal growing conditions during the winter production season while vine scorch was thought to be due to accumulated pesticide spray phytotoxicity. The purpose of Dr. Simone's trip was to evaluate the production situation and recommend changes in present production practices to offset the phytotoxicity problem.

In carrying out his assignment, Dr. Simone visited the Little Belize production site and examined various fields of cantaloupes differing in age, variety, pesticide history and general culture. He met with numerous growers, questioned them about differences in the production of cantaloupes, collected a number of samples and took photographs. He also examined root, stem and leaf tissue for evidence of pathogenic organisms. While making his observations, he noted that the small melon problem was evident in all fields in a rather uniform fashion for fields at or near harvest, regardless of variety. However, he found that the foliar scorch symptoms were only evident in fields of harvest age or within a week of harvest and in only 5-20% of the plants. Among the various symptoms exhibited by diseased plants and described in his report were the following: scorch symptoms were bilaterally symmetrical, progressing from the oldest to the newest foliage on a vine; scorched leaves were cupped upward with no foliar wilt observed; individual plants exhibited one-sided vine injury with remainder of plant symptomless; and newest growth on the vines was generally unaffected. The cultural practices used in cantaloupe production by the farmers in Little Belize were also examined as were their pesticide use practices in order to obtain the information needed which might have made it possible to determine what factor or factors were responsible for producing small fruit and causing scorched vines.

On the basis of his observations and experience and information provided by growers, Dr. Simone proposed six hypotheses as possible explanations for the problems occurring in cantaloupe production in the farm community of Little Belize. These hypotheses were: 1) contact pesticide burn, 2) accumulated pesticide burn, 3) insufficient watering, 4) bacterial wilt, 5) southern blight disease, and 6) wilt disease. He examined each hypothesis closely, reviewing all the observations and facts which would support its acceptance, and finally concluded that a fungal wilt disease (hypothesis 6) was involved in the Little Belize production area. Although the latter seemed to be the most plausible explanation to him based on his knowledge of cantaloupe disease problems in the midwest and Florida and the data generated by microscopic examination of diseased tissue, he noted that certain key symptoms were missing, i.e. there was no vascular discoloration or wilting of plants. Despite this, he felt that the cool climate and strain of fungus involved could explain the lack of these symptoms.

Having postulated that a fungus was the probable causal agent, Simone in his report proceeded to cite the following evidence for his decision to implicate fungi in the genus Fusarium rather than in Verticillium:

1) tomatoes and watermelons growing in the same area as cantaloupes were not affected by wilt, a situation which would be true for Fusarium, but not for Verticillium, as the latter attacks both crops,

2) no microsclerotia were observed in stem or root tissue in a microscopic examination, although they would have been present if Verticillium had been involved, and

3) a toxin could help explain the leaf scorch symptoms and there is more information in the literature to support toxin production in Fusarium than Verticillium.

After arriving at these conclusions, Dr. Simone attended a grower meeting to explain what he believed to be the problem affecting cantaloupe production in the area and what were likely cultural and chemical control measures. He also visited a second production site in Chunox, but the fields there were all younger than at Little Belize and had no similar symptoms showing at the time. Samples were not collected due to the low probability of choosing infected, symptomless plants from all the healthy ones.

Simone returned to Florida on February 11 with select plant material for laboratory verification of his diagnosis. Part II of his report consisted of the results of laboratory tests conducted in Florida while Part III was a final assessment of the disease situation and control recommendations for the future. In the laboratory report, he went into some detail in describing the procedures used for trying to isolate and identify the causal organism of the disease, and listed the pathogenic fungi which were recovered in the root and stem samples brought back to Florida. The majority of isolates were species of Fusarium, specifically F. semitectum and F. equiseti; there were few recoveries of F. oxysporum. Simone believed the high frequency of recovery of semitectum and equiseti was quite incriminating even though neither species posed a problem to cantaloupes in the production areas of Florida. In his opinion, the presence of these fungi in the vascular tissue and associated parenchyma cells could contribute to a reduction in water movement through the stems as well as reduced uptake due to deteriorated root systems. He speculated that the additional presence of a third fungus (in the genus Rhizoctonia) would also contribute to root and stem deterioration.

In his concluding remarks, Simone stated that although the actual role of F. equiseti and F. semitectum could not be proved to be responsible for the symptoms observed in cantaloupes in Belize, he felt that the greatest amount of evidence existed to support a disease hypothesis rather than one for pesticide phytotoxicity. Supported by the laboratory results, he now considered that the foliar scorch symptoms seen in cantaloupes during the cool growing period of fruit maturity in Little Belize were caused by the colonization of root and stem by these two species of fungus (with the possible release of a toxin), rather than by infection with F. oxysporum f. sp. melonis, the causal organism of Fusarium wilt disease in cantaloupes, as he had speculated when he was in Belize. He conducted a literature search of equiseti and semitectum and found a surprising number of instances of pathogenicity by these two fungi in different crops. He reported that Israeli researchers believed the pathogenic role of F. equiseti had been underestimated on cucurbit crops and had substantiated a close association of this fungus with "wilt" type diseases on melon crops. There was also a record of a toxin produced by this fungus in the laboratory that will produce various symptoms, e.g. chlorosis, necrosis and wilt, on forage legumes and grasses. The second problem of below market-grade melons he felt could be attributed to both a cooler growing season and the low level of stem/root disease that would limit fruit size.

As to his recommendations for control, he emphasized that attention should be given to the needs of crop rotation since the continuous cropping of any vegetable will lead to a soil buildup of pathogenic fungi that will cause increasing damage on the crop. He stated that proper crop rotation (including leaving land fallow) will be the only way to circumvent such

diseases as Fusarium wilt and that a 3-4 year rotation to non-host crops may be needed.

Evaluation of the Economic Impact on Caribbean Countries of a Ban on the Use of Ethylene Dibromide for Quarantine Fumigation of Fruit Entering the United States, February 13 - March 1, 1984

On October 1, 1983, the U.S. Department of State sent an information cable to all diplomatic posts notifying appropriate personnel of an emergency order issued by the Environmental Protection Agency (EPA) on September 28 which suspended the registration of pesticide products containing ethylene dibromide (EDB) for use as a soil fumigant for agricultural crops. This order also announced the cancellation and phase-out of all other major pesticide uses of EDB, including the quarantine fumigation of citrus fruits, tropical fruits such as mango and papaya, and other fruits and vegetables that are hosts for tropical fruit flies. The regulatory action by EPA was taken as a result of the Agency's determination, based on a study by the National Cancer Institute and other evidence, that ethylene dibromide posed a significant risk of oncogenic, mutagenic and adverse reproductive effects in humans. According to the order, the use of EDB was to be phased out by September 1, 1984 and, in the intervening period, EPA was to issue interim tolerances on permissible residue levels of this pesticide on certain crops to protect public health.

The importance of EPA's action lay in the fact that ethylene dibromide and methyl bromide (MeBr) are the two fumigants approved for use in regulatory treatments of fruits and vegetables produced in Latin America and the Caribbean before they are shipped to the United States. Fumigation of these commodities is required to kill all life stages of a number of genera

and species of fruit flies and other pests which attack these food crops. EDB is the more widely used and approved fumigant because only a relatively few fruits and vegetables are tolerant to methyl bromide at the dosage rates and time interval necessary to eliminate the pest problem.

In response to the Washington cable, the USAID Mission in San Jose, Costa Rica sent a reply requesting that EPA take immediate action to extend the deadline on the ban of EDB to allow more time for researchers to develop or change fumigation procedures that would be acceptable to the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (Plant Protection and Quarantine Programs) as well as the EPA. USAID Missions in Honduras, Belize, El Salvador, Haiti and the Dominican Republic also expressed their concern for an extension of the EPA deadline and supported the Costa Rican Mission's proposal. However, the detection by FDA of EDB in ground water in Florida and California and in processed grain products in several states caused EPA to reassess its position and subsequently decide to establish temporary tolerances on tropical fruits by February 29, 1984, allowing interested parties to submit information and comments on the proposed tolerances until March 4, 1984.

USAID/Washington responded to the requests of the Central American and Caribbean Missions by asking CICP to organize a fact-finding team to determine what the economic impact of EPA's regulatory action would be on nations that were scheduled to benefit from the Caribbean Basin Recovery Act. This Act, signed into law on August 5, 1983, contains provisions which allow Caribbean nations to export nearly all of their products to the United States duty-free and establishes a policy of providing political and financial incentives to governments, institutions, and private individuals which is intended to foster a favorable climate of trade and economic

growth for countries of the region. Since a ban on the use of EDB and the establishment of extremely low tolerance levels for permissible residues of this fumigant in vegetables and tropical fruits would seriously affect the export of these agricultural products to the U.S. from these countries, the fact-finding team was also requested to accomplish the following tasks: 1) analyze the applicability of possible alternative treatments, 2) evaluate existing and possible modified techniques for fumigation with EDB, 3) evaluate available EDB analytical methodology and capability of regional laboratories with a view toward a possible certification program, and 4) provide information and analysis to enable USAID to develop a position vis-a-vis a decision to intervene in the regulatory process followed by EPA for the establishment of tolerances on tropical fruits for EDB.

The fact-finding team that CICP assembled consisted of the following three individuals: William Bolton, Postharvest Institute for Perishables, University of Idaho; George E. Cavin, retired USDA pest regulatory expert; and Joseph G. Cummings, retired EPA pesticide chemist. These three men met in Washington, D.C. on February 13 with staff members of USAID's Latin America and Caribbean Bureau and Science and Technology Bureau to review EPA's decision on ethylene dibromide and discuss operational plans for their assignment. The impending deadline in early March set by EPA for receipt of comments on its EDB action made it necessary for each member of the team to work independently to develop the needed information within his particular discipline. At this time also, a meeting in Washington on February 27 was scheduled for them to reunite and prepare a final report with recommendations and conclusions for USAID consideration.

In carrying out their assignment, team members visited U.S. government officials in the Food and Drug Administration (FDA), Environmental Protection Agency (EPA) and personnel of the USDA's Economic Research Service (ERS), Agricultural Research Service (ARS), and Animal and Plant Health Inspection Service (APHIS) in Maryland, Florida, New Jersey, and Virginia to obtain appropriate information on different aspects of the problem, including data on the effect of EDB and MeBr treatment on an assortment of tropical fruit and vegetables; entry status of various tropical fruit and vegetables into the United States; residue data for citrus, mangoes, and papaya; statistical data on U.S. imports of tropical fruits from Caribbean Basin countries; distribution and occurrence of different species of fruit fly pests in the Caribbean region; information on analytical procedures currently being used to detect residues of EDB in food; and research being conducted on quarantine treatments for fruit fly infested tropical fruits produced in south Florida. The nature of their assignment made it necessary for team members to visit other countries in the region, and therefore Cavin went to the Dominican Republic and Jamaica from February 17-22; he later also went to Costa Rica for three days and was joined there by Cummings. In Jamaica, a Conference on Postharvest was being presented, sponsored by the Postharvest Institute for Perishables, and the attendance there of representatives of many Caribbean Basin countries provided an excellent opportunity for Cavin to discuss with them their nation's plans for increased production of tropical fruits and vegetables and their views as to the effect a ban on EDB would have on their nation's agricultural economy. During his visit to the Dominican Republic, Cavin held discussions with a number of people concerning USAID's effort to encourage commercial production of export quality mangoes and the effect a ban on EDB

would have on this effort; he also visited mango plantings and a new fumigation chamber in Santo Domingo and, with APHIS personnel, reviewed mango production and fumigation facilities in Haiti. In his visits to Jamaica and the Dominican Republic, and later with Joseph Cummings to Costa Rica, Cavin was able to meet with USAID rural development officers, agricultural attaches, APHIS personnel stationed overseas, Vice-Ministers of Agriculture, Sanidad Vegetal workers and representatives of regional organizations to obtain their views on the effect of an EDB suspension on a particular country, to receive information on projected agricultural production in the Caribbean Basin, and to discuss research on alternatives to EDB fumigation. The team returned to Washington on February 26 and spent the next few days preparing their report.

In reviewing the list of fruit flies of quarantine importance in Latin America in their report, the team discussed information on the status of important species in Mexico, Central and South America, and the Caribbean Islands and made observations on the regulatory measures taken to restrict the movement of fruit from fruit fly infested areas. They noted that, although the state of California requires EDB fumigation of citrus from Caribbean fruit fly infested areas, this species is not considered of regulatory significance in citrus by the USDA. The fact-finding team also noted that there is no Federal Domestic Quarantine to regulate the marketing of tropical fruit produced in south Florida to other parts of the continental United States, and they questioned the USDA requirement for EDB fumigation of tropical fruit from the Caribbean Island nations in the absence of this federal quarantine. Another pest which also occurs in tropical fruit producing areas of south Florida is the papaya fruit fly, *Toxotrypana curvicauda*. Since papaya is not a host of the two *Anastrepha*

species of regulatory significance in the Caribbean Island nations, shipments of this fruit from these islands can enter the continental United States without being fumigated with EDB.

With regard to the effect the decision to suspend the use of EDB would have on trade within the region, the team's report stated that a curtailment of this chemical's use would impact immediately on the exportation of mangoes, papaya and citrus (except lemons and limes) from Mexico, Central and South America and would also affect future planned exportations of other tropical fruits, such as carambola, anona, and mamey, while in the Caribbean Island nations, only the exportation of mangoes was expected to be greatly affected at the present time. However, several of the latter countries had reported the initiation or expansion of commercial plantings of other tropical fruits, such as carambola, anona, sour sop, guava and various sapotes, with an eye towards the export market of the United States, and these fruits would also be affected by EDB's suspension. A variety of other fruits and vegetables presently being exported to the U.S. from Latin America and the Caribbean, such as yams and okra, also require fumigation as a condition of entry to the U.S. because of insect pests other than fruit flies but, as these commodities are tolerant to methyl bromide, they are not affected at the present time by a ban on the use of EDB.

In their discussion of possible alternative methods of treatment of fruits and vegetables for quarantine purposes, the team concluded that there appeared to be no short-term viable alternative to EDB fumigation. They noted that tropical fruits do not tolerate methyl bromide treatment and that, since most fruit ripens rapidly, there is a corresponding short shelf life. The use of magnesium or aluminum phosphide fumigation requires

3-4 days in order to kill the target pests, and consequently this would further shorten the fruit's shelf life and make it unmarketable from the standpoint of quality. Their report further stated that tropical fruits will not tolerate the chilling requirements and time involved to eliminate the target pest through cold treatment nor, in their opinion, could tropical fruits withstand all presently approved hot water dips, vapor heat treatment, or hot/cold combinations. The applicability and use of these different kinds of treatments was a rather moot point in any case, as the team found that the necessary equipment and technology were unavailable in the affected countries. They believed that some modification in fumigation practices with EDB--such as fumigation in field boxes rather than in commercial packs or allowing a longer aeration period using forced air following fumigation--could substantially reduce, but not completely eliminate, EDB residue levels in treated fruit.

In discussing these alternative treatments, the team pointed out that the tolerance of tropical fruits to the different treatments, such as irradiation, vapor heat, cold treatment, other fumigants and their combinations, will vary by plant variety; in addition, the ability of the target pests to tolerate the treatment will vary among genus and species. As a consequence, a regulatory treatment developed in Hawaii against the Mediterranean fruit fly in mangoes may not be applicable for treatment of this pest in sapotes in Central America; nor, by the same token, can treatments developed in Florida to eliminate the species complex of Anastrepha fruit flies be assured of providing protection against the complex of species in this genus occurring in Central or South America. For this reason, the CICP consultants considered it likely that the APHIS authorities would require results of extensive testing of these alternative treatments by

recognized researchers conducted on-site in the various habitats within the Caribbean Basin countries before these methods would be accepted and approved as regulatory treatments for tropical fruit being exported to the U.S. After considering the various alternative treatments to EDB fumigation, the team stated their belief that a major effort should be directed by USAID at developing postharvest irradiation as an acceptable regulatory treatment. Development of other nonchemical methods that can be accurately monitored through instrumentation and which would thus reduce the need for APHIS supervision of in-country treatments of exportable agricultural crops was also recommended.

The CICP team also discussed the anticipated regulatory actions that EPA would take and speculated that the establishment of a 30 ppb tolerance level for EDB in citrus and papaya appeared imminent. Information they had received indicated that EPA would delay action on mangoes until additional research was completed on the period of time needed for the depletion of residues on this crop. Therefore, the immediate economic impact on Caribbean Basin countries would derive from the pending tolerance on papaya and citrus. Of these two crops, citrus was of relatively minor concern because, among other reasons, there existed a low volume of trade in this commodity between the U.S. and the other countries of the region. Therefore, major concern centered on papayas. The team was advised that the 30 ppb tolerance level contemplated was based on the assurance given by APHIS personnel that a treatment had been devised for Hawaiian plant quarantine purposes that employed reduced EDB dosages in conjunction with a hot water dip. However, in the team's opinion, this treatment could not be adopted in Caribbean Basin countries because of the differences in variety and pests and inadequate equipment and, consequently, they emphasized that the

contemplated level of 30 ppb for papayas could not be met under Caribbean Basin conditions and would cause serious economic hardships on export firms in the region. Therefore, they recommended that USAID take advantage of the 30-day comment period after EPA publishes the proposed EDB residue tolerance level to make known the specific needs in the Caribbean region for a higher tolerance on papayas, centering their argument on the use of a lower diet factor for papaya (and tropical fruits in general) in the risk assessment process. On this basis, the team felt that a tolerance level of about 300 ppb on papaya could be justified.

For this assignment, the CICP consultants were asked to survey laboratories for their capability of analyzing fruits for EDB residues before they were shipped to the United States, and they reported that the only Caribbean Basin area laboratory found to have the required capability was the Inciensa Laboratorio de Alimentos at Tres Ríos, Costa Rica, although there may have been others in Central America that were not visited. The director of the laboratory was enthusiastic about expanding operations to include the analysis of fruit for EDB residues should such a program be required. The team felt that this laboratory has excellent facilities and staff and would be capable of carrying out a type of certification analysis on a national or regional basis. As an alternative to this, they mentioned a USAID-funded pesticide residue analytical laboratory at the University of Miami in Florida which has the capability to perform a similar function if logistics or the shipping of samples and obtaining of analytical results could be worked out.

In their summary of the situation, the team expressed the opinion that a likely result of the suspension of EDB use in the U.S. would be a suspension of its use in most other hemispheric nations, since most nations of

the Western Hemisphere follow the lead of the United States with respect to pesticide use policy. Thus, not only would the region's exports to the U.S. be affected, but also its exports to Canada and Japan that transit the U.S., exports to Europe, and even trade between neighboring Western Hemisphere nations which have dissimilar fruit fly and other pest complexes. Although the immediate economic impact may seem relatively insignificant for smaller countries, such as Belize or Haiti, in the team's estimation the overall immediate impact would be very serious and, in their report, they provided examples from selected countries of the expected increase in tropical fruit production to indicate the widespread interest in the Caribbean Basin initiative throughout the region. It is illuminating and instructive therefore to record some of the comments expressed by delegates to the Postharvest Conference in Jamaica and cited in the team's report: "Any decision by the U.S. government which would result in an embargo on these major exports from the Caribbean Basin countries would bankrupt the CBI program. As no alternatives can be offered by agencies of the U.S. government at this time, such a decision is incomprehensible." Other reported comments used to describe EPA's pending action on EDB were "nullification of the Caribbean Basin Initiative," "trade barrier," and "embargo."

Jamaica, in their official response issued by the Minister of Agriculture, asked for an extension of the use of EDB until viable alternatives are available, for assistance with alternative methods once available, and for assistance with an eradication program for the Caribbean fruit fly. Acutely aware of this reaction and attitude, the team observed that not only was it obvious that a regulatory decision which would immediately restrict Caribbean Basin exports of citrus, mangoes and papaya

would cause obvious financial losses, but that such a decision would also be considered as highly inconsistent with previous policy and would produce yet another negative reaction politically among nations of the region. The team accordingly emphasized that time was needed to research alternative chemicals and/or methods for the treatment of fruits and vegetables now requiring fumigation with EDB, and they strongly suggested that a tolerance level for EDB "acceptable to industry" be established for a two-year period, as by the end of this time effective alternatives should have been developed.

After considering the technological status of possible alternative treatments for EDB and determining what the economic and political consequences might be of the U.S. decision to suspend the use of EDB, the three men offered the following conclusions and recommendations:

(1) a tolerance level of 30 ppb in papaya contemplated by EPA would not be adequate for fumigated fruit arriving at U.S. ports from Caribbean Basin countries,

(2) the processing of any major portion of affected mango and papaya is not considered a viable solution,

(3) a feasibility study should be initiated within Central America to determine needs for development of techniques and procedures which will enable Caribbean Basin nations to meet the United States, European and Canadian quarantine requirements in the long term,

(4) research to construct residue decline curves on EDB in tropical fruits, particularly papayas and mangoes, should be supported, in cooperation with USDA/APHIS, USDA/ARS, and the Interamerican Institute for Cooperation on Agriculture (IICA) based in San José, Costa Rica, and

(5) a reassessment by USDA/APHIS of quarantine requirements for tropical fruit (except citrus and papaya) imported into the continental United States from the Caribbean Basin nations should be immediately requested by USAID, in order to eliminate the present double standard of application, one for domestic production and another for imported products. Removal of this double standard would eliminate the need for EDB fumigation of tropical fruits from the Caribbean nations and allow them to proceed with expansion plans for export of these commodities.

International Center of Insect Physiology and Ecology (ICIPE) Project on the Bases of Plant Resistance to Insect Attack, Kenya, June 10-29, 1984

This project was initially started in 1978 with limited funding from the government of Australia for support of rice brown planthopper research at IRRI. In 1979, additional support was obtained from IITA and USAID and, for the period 1979-1983, USAID was the primary donor for this program. In May 1981, a CICP team visited ICIPE to review the project's progress, organization, effectiveness, adherence to project plan and objectives, and potential research applications. Based on recommendations contained in the team's report, USAID agreed to commit funds for an additional three-year period to support this program's continuation. From June 17 - July 12, 1982, a four-man CICP design team went to Kenya to prepare a Project Paper for a new Bases of Plant Resistance to Insect Attack (BPRIA) project. This team was led by Fowden G. Maxwell, entomologist, Texas A&M University and, for the period under discussion, Maxwell was asked to return to ICIPE to update the 1982 proposal. It was felt that a revision of this proposal was needed because of changes in project leaders and new directions in some

facets of the research; also, there had been a turnover in some research staff, especially predoctoral and postdoctoral fellows.

As finally submitted to USAID, the proposal requested support of $4,726,000 for a five-year period (1984-1989) to continue the BPRIA research program. The research was to be conducted at ICIPE's Mbita Point Field Station by a team comprised of a research project leader, three scientists supported by field and laboratory technicians, and one predoctoral and two postdoctoral research fellows. The team was to be assisted also by ICIPE's basic support units of chemistry, sensory physiology, histology, insect pathology and fine structure. The project, if funded, would continue to emphasize research on host plant resistance to the stem borers of maize and sorghum and pod borers of cowpea. This borer complex is the most destructive pest group in Africa on primary food crops. Secondary emphasis will be placed on the sorghum shootfly, a highly destructive pest on sorghum in Africa and Asia. The BPRIA research team will identify and elucidate the principles determining the susceptibility, tolerance or resistance of different cultivars of maize, sorghum and cowpea to crop borers under different cropping systems in order to accomplish their principal objective of ensuring that plant breeders at National and International Agricultural Research Centers have basic information for breeding resistant cultivars which will provide a major first line of defense against insect pests of the small subsistence farmer of Africa. The proposed research will also contribute to the development of integrated pest management (IPM) methodology within intercropping systems by helping to produce resistant varieties which will constitute the foundation upon which other IPM technology can be built.

ICIPE's interest in the proposed research is based on a recognition that pests affecting cereal and grain legume crops in the rural tropics cause severe widespread losses in Africa and that research on the problem would help to reduce these losses. As noted above, the primary thrust of the research contemplated is the control of stem borers of cereals and pod borers of legumes through breeding for plant resistance. The Bases of Plant Resistance to Insect Attack research team was to obtain germplasm previously screened for resistance to certain species of insects from International Agricultural Research Centers, National programs and Collaborative Research Support Programs (CRSP) in the U.S., grow the material at Mbita Point Field Station to confirm resistance, or lack of it, to stem borers, pod borers and other local pests, then characterize the resistance and study the basic physical, morphological and chemical mechanisms, including the effect of the various levels of resistance on the population dynamics of pest species.

The selection of plant resistance to insects as the appropriate technology to extend to African farmers was based on a long history of success of this method in the U.S. and other developed countries as well as the significant progress that had been made in the development of resistant varieties at some of the International Agricultural Research Centers. The research proposed for this project would concentrate on insect pests of sorghum, maize and cowpea - important food crops for millions of people in Africa and other developing areas of the tropics. The expected benefits to be derived from this project are:

1) development or improvement of resistance screening methodology for maize, sorghum and cowpea to target insect species which would be provided to national and international plant breeding programs,

2) identification of new sources of resistance to target insect species in maize, sorghum and cowpea,

3) identification and clarification of the biophysical and biochemical nature of maize, sorghum and cowpea resistance to insects,

4) determination of the genetic basis of resistance for use by plant breeders in national and international centers of agricultural research involved with varietal development for regions of Africa,

5) training of African scientists in plant resistance methodology,

6) interchange of germplasm and methodology through formal and informal cooperative relationships with national, international and CRSP research programs, and

7) publication of results in national and international refereed journals.

The final result of the technology that will be developed by this project will be that varieties more resistant to key endemic pests of corn, sorghum and cowpeas will be made available to the small farmers of Africa. Although insecticides are a possible means of controlling stem borers, it is not practical for the subsistence farmer in Africa and therefore, the development of crop varieties resistant to these pests would be especially important to him. In fact, the proposal declared that resistant varieties, together with cultural and biological control practices, constitute the only practical means to reduce crop losses in Africa.

Establishment of Pest Management Unit in the Grenada Ministry of Agriculture, Grenada, September 9 - October 2, 1984

On July 23, 1984, USAID's Regional Development Office for the Caribbean in Barbados approved a grant to the government of Grenada to

finance an Agricultural Sector Revitalization Project. The goal of this project is to increase the productivity and income of private agricultural entrepeneurs and workers in Grenada by establishing a policy environment which offers positive incentives to private farmers and agro-industry firms and by strengthening the capacity of the Ministry of Agriculture and private producer associations to provide essential support services to the private agricultural sector. Among the principal activities to be supported by the project are: 1) creation of a divestiture facilitation fund, 2) promotion of increased use of fertilizer in banana and cocoa, 3) establishment of a pest management unit in the Ministry of Agriculture, and 4) rehabilitation of the central market facility.

As a condition precedent to the disbursement of funds for the pest management unit, USAID regulations required that an environmental assessment be made for the pesticides to be used in the Unit and, therefore, the USAID office in Grenada in August specifically requested that CICP contract entomologist Dale G. Bottrell, University of Maryland, to provide technical assistance in the establishment of the pest management unit and preparation of the environmental assessment. The Grenada office also asked that Bottrell provide an analysis and set of recommendations regarding the proposed organization and level of effort required to establish the pest management unit in the Ministry of Agriculture and prepare recommendations for the kinds of technical assistance and training that may be required to aid in the Unit's establishment.

As background information for his report, Bottrell reviewed recent events that had shaped U.S. interest in Grenada and described USAID's program in that country. He noted that the pest management unit was being established at the request of the Ministry of Agriculture because it had no

organized unit for discharging its responsibilities for monitoring the incidence of pest infestations, educating farmers on pest control techniques, implementing pesticide regulations, and providing technical assistance and other support to organized pest control efforts. The goals of the new Unit are:

1) to ensure optimal effectiveness and efficiency of pest management practices by farmers and commodity organizations,

2) to minimize problems of pesticidal poisoning and contamination to humans, natural environment and economic resources,

3) to bolster pest management programs aimed at specific crops not presently included in organized crop protection campaigns or at specific pests that represent a threat to the nation's interest, and

4) to strengthen plant and animal quarantines at airports and seaports.

USAID support of the pest management unit will be $265,000 for 18 months. The Unit will be established within and administered by the Ministry of Agriculture (MOA) and will be staffed with a manager and 4-6 junior-level MOA employees who will be directed from other duties. Employees of regional and international organizations may be seconded to work in this Unit also, where appropriate. USAID funds will be used for training and technical assistance as required to upgrade and develop needed skills within the Unit. The Unit is being organized in a way to draw from, and coordinate with, the work of MOA extension personnel, Ministry of Health, commodity organizations, and other public and private organizations.

In his report, Bottrell stated that Grenada's current efforts in pest management span a diverse range of pest problems and programs, noting that the latter were fragmented, heavily oriented toward unilateral use of

pesticides, and insufficiently staffed with properly trained personnel. He proposed an organizational structure for the Unit which was intended to improve cooperation and cohesiveness among the different pest management efforts discussed in his report. If adopted, he believed that this arrangement should consolidate and streamline many of the related activities and foster a "common theme" approach to pest management. He recommended that the Unit should immediately realign those pest control service programs (namely in cocoa and banana) that focus unilaterally on chemical means of protection, and that a special effort should be made to advance integrated pest management (IPM) and pesticide management in these crops and others (especially vegetables) heavily treated with chemicals.

Urging that the Unit should adopt policies and develop programs that encourage comprehensive, integrated approaches to crop protection, Bottrell further recommended that the pest management unit should immediately determine the suitability of IPM in the various crops in Grenada and, where appropriate, develop guidelines for its use. The Unit should contact organizations that have experience in developing IPM in crops grown in Grenada and utilize all existing information that applies to Grenadian conditions. An important aim of the Unit will be to initiate some new research in pest management with emphasis on identification and testing of IPM techniques, including pesticide application techniques. Training will be given a high priority in the project, with short-term training for Unit staff, MOA extension, and commodity association personnel receiving special emphasis. Two overseas training activities will be funded - one chemist will participate in a three-month course in pesticide residue analysis at the University of Miami (Florida) School of Medicine while a MOA officer

will be trained in plant quarantine at a three-month USDA course in Hyattsville, Maryland.

One final activity of the Unit will be to provide farmers, private firms, extension workers, and commodity organizations with help in diagnosing pest problems, organizing pest management demonstrations, carrying out pest surveys, etc. Special assistance will also be provided when the pest problem represents a threat to the national interest as in the case of newly introduced pests, for example. To meet its objectives, the Unit will require pesticides (purchased with MOA funds) for use in research plots, farmer demonstrations, and training. In some instances, the Unit will actually carry out operational pest control programs that use pesticides on a small scale. USAID funds, however, will not be used to purchase any pesticides (except perhaps for small scale experimentation).

The pesticides to be used in the pest management unit were reviewed by Bottrell in the Environmental Assessment he prepared for this project as a condition precedent to disbursement of USAID funds for the Unit. USAID will monitor pesticide use in this Unit to ascertain that pesticide procedures specified in the environmental assessment are followed. If USAID funds are used to purchase pesticides for small-scale experimentation, the Agency must give approval prior to the purchase.

Development of Alternatives to the Use of Ethylene Dibromide, Mexico, September 19 - October 16, 1984

One of the recommendations proposed in the study on the use of ethylene dibromide (EDB) which was reviewed on pp. 40-50 urged USAID to support the development of possible alternatives to the use of this fumigant and, in accepting this recommendation, USAID/Washington requested CICP

consultant George E. Cavin, retired USDA pest regulatory expert, to prepare a protocol for the initial screening of methoprene and phosphine (magnesium phosphide) as candidate replacements for EDB in the quarantine treatment of mangoes infested with the Mexican fruit fly, Anastrepha ludens (Loew). Following acceptance of this protocol, Mr. Cavin was also asked to organize the study, assure that it was conducted in a scientific manner, and assist in its evaluation.

The site selected for the work was the joint U.S. Department of Agriculture (USDA) - Secretaría de Agricultura y Recursos Hidráulicos (SARH) rearing facility for A. ludens in Monterrey, Nuevo León, Mexico, since adequate facilities and technically trained people were readily available there. Cavin visited the site on September 19 and received assurances that facilities and personnel would be provided to infest the fruit. He also obtained the assistance of scientists at the Instituto Tecnológico y de Estudios Superiores in Monterrey in the conduct of this study.

As the tests did not require his continued presence, Mr. Cavin made several trips between Monterrey and his home in New Braunfels, Texas during the month-long assignment. On September 30th, 600 mangoes were exposed for 2-1/2 hours to infestation by several thousand flies. Female flies were seen to be very selective in their choice of mangoes in which to lay their eggs, ignoring both fully green and mature fruit. The mangoes used were an export variety, Kent.

Treatment of the fruit with the insect growth regulator, methoprene, for control of the fruit fly larvae was scheduled for October 3rd, while October 4th was chosen as the date for fumigation with phosphine, as it was anticipated that eggs as well as some early first instar larvae would be

present on these dates. The treatments with methoprene consisted of hand dipping of individual mangoes and spraying of fruit through the nozzles on the grader belt. Ten mangoes were used in each treatment with three replicates. Two mangoes from each treatment were frozen for later analysis of pesticide residues. The fumigation experiment consisted of the application of magnesium phosphide in fumicells, rather than phosphine in the gaseous state, to three boxes of 30 infested mangoes each at two concentration levels and three exposure times. Probe lines were installed in the atmospheric fumigation chambers to monitor concentration of the gas.

Having gone back to his home in Texas, Cavin returned to Monterrey on October 15 in order to be present when the percentage of pupation of the fruit flies was determined. However, when he arrived he learned that no pupae had been detected in the check of the phosphine treatments when it had been opened that same morning. The following day, the check of the methoprene test was also opened and, again, no pupae were found. It was decided to cut open the mangoes and examine them for fruit fly larvae and, during this inspection, 15 third instar larvae were found in the 30 mangoes examined. Weather records for the area showed that temperatures for the previous week had averaged only about 20°C, and this obviously had delayed development of the larvae.

Although the level of infestation of the fruit was not very favorable, Cavin stated that he was hopeful of obtaining sufficient data to make a judgment as to whether additional tests of these materials should be undertaken by the Interamerican Institute for Cooperation on Agriculture (IICA) in the spring of 1985. Additional studies using grapefruit as the host fruit had been initiated by the Instituto Tecnológico in Monterrey, in cooperation with Sanidad Vegetal, to determine if an adequate infestation

level could be obtained. If so, the methoprene treatments and phosphine fumigation tests would be repeated on grapefruit. Efforts were also underway to use other varieties of mangoes in these tests, including the native variety. The importance of this study was dramatically illustrated in Cavin's report by the example cited of Mexican citrus growers who severely burned between 100 and 1000 tons of oranges after fumigation with methyl bromide, which made the oranges unfit for the fresh fruit market.

PROGRAM EVALUATION OR DESIGN

CAMEROON

CENTRAL AMERICA

BURMA

Evaluation of the Centre Regionale de Formation Phytosanitaire de Yaounde (CREFPHY), Cameroon, September 27 - October 31, 1983

In May 1983, CICP Consultants Edward H. Glass and James Goodwin travelled to the United Republic of the Cameroon in response to an USAID request for assistance in the evaluation of the Regional Food Crop Protection (RFCP) Project as it pertained to its implementation in the Cameroon. Apart from their principal assignment -- which was to design a work plan for a new national Food Crop Protection Project -- they were asked to examine and define the role of the Centre Regionale de Formation Phytosanitaire de Yaounde (CREFPHY) as a training center in light of the training needs of the countries participating in the RFCP project, but particularly with regard to the Cameroon. In their report, the two men reviewed CREFPHY's activities, capabilities, resources, and constraints and concluded that the Center should continue to provide in-country training in the basics of crop protection and integrated pest management (IPM) to extension workers and food crop protection personnel in the Crop Protection Service. They recommended that it also continue its role as a regional training center, and suggested that it should explore the possibilities for cooperation and collaboration with the extension component of the National Cereals Research and Extension project.

The USAID/Yaounde Mission accepted the conclusions and recommendations of the Glass/Goodwin report and requested CICP's assistance to further evaluate the role and capacity of CREFPHY as a training center. This second evaluation was a more intensive review of the center and was conducted by James E. Hunter, plant pathologist, Cornell University, and George L. Teetes, entomologist, Texas A&M University. The two men were asked to

perform a number of tasks in this assignment, among which were the following:

1) determine if the role of CREFPHY is still valid as a training component of the RFCP project,

2) identify how the IPM package will be effectively transferred to CREFPHY from the Crop Protection Service and from CREFPHY to the extension service,

3) identify the coordination needed between CREFPHY, the Crop Protection Service and other extension entities for the preparation of extension material to ensure that IPM packages will be available to farmers,

4) design a work plan for the CREFPHY training center to meet the extension needs of the IPM Pilot Project,

5) prepare a scope of work and qualifications statement for the Training Officer who will be hired to assist in project implementation, and

6) work closely with government officials to ensure that the plan of action, goals and objectives of the training component are well defined and make sure that the government understands its responsibilities during project implementation.

CREFPHY was one of the two Regional Training Centers established as part of the Sahel Regional Food Crop Protection project. Its primary purpose was to serve the Cameroon and the other Sahelian countries included in the RFCP project through the diffusion of knowledge about IPM to Crop Protection Service personnel and other government agencies, the production of course materials and training modules, and the organization of training courses and conferences. Hunter and Teetes reported that although some training courses and conferences had been presented at the Center, and some

training materials had been developed, the training had not yet reached the local extension agent (Agricultural Technician), much less the farmer. This training also had not been specific enough to help the technician with local problems.

As originally conceived, CREFPHY was supposed to work together with the Crop Protection Service to ensure that IPM technologies are diffused via training by CREFPHY to ultimately reach the farmer through the extension agent. However, the consultants found that the IPM concepts proposed for the project lacked a food crop protection capability and, for various reasons, development of IPM technologies in the RFCP project had failed. Even if the crop protection capability had been developed, they believed the research backstopping to supply the requisite technology lagged far behind the need. They noted that the relationship of CREFPHY to other institutions in the Cameroon with agricultural training and research responsibilities was not well-defined and that, although some higher-level specialists (Chiefs of Base, Brigade, etc.) had received generalized training in crop protection, no Agricultural Technicians had been trained. They lamented the inability of the extension service to perform its duties because of the lack of trained personnel, but explained that this fact underscores the importance of CREFPHY as a national crop protection training center for extension workers.

Before the role and capacity of CREFPHY as a National Crop Protection Training Center for extension workers could be assessed, the team made a number of assumptions:

1) CREFPHY is not yet an officially recognized entity and has not been assigned a position within the organization of the Ministry of Agriculture,

2) the recommendations of the Glass/Goodwin report to USAID/Yaounde to initiate an IPM Pilot Project will be approved,

3) USAID and the government of the Cameroon will develop a Bilateral Food Crop Protection Project, in place of the Regional Food Crop Protection Project,

4) the Ministry of Agriculture will be fully committed to food crop production and protection,

5) Agencies outside the Ministry of Agriculture will cooperate in the Food Crop Protection Project, especially in terms of research needs,

6) the Ministry of Agriculture will allocate the necessary funds and resources, and require the coordination and cooperation of appropriate agencies,

7) CREFPHY instructors with the M.S. degree will be qualified to train extension personnel in the practice of IPM on food crops,

8) Individuals trained at CREFPHY, particularly those trained in specific pest-disease problems in their local area, will be provided resources, such as transportation, and will attempt to use their knowledge by training food crop farmers to manage pest/ disease problems,

9) the Cameroon government will establish a mechanism to coordinate the many duplications of effort and prevent conflicting recommendations from different projects, and

10) CREFPHY will be responsible only for in-service training of extension workers. Teaching at the college level and agricultural research will be the responsibility of other government institutions.

In carrying out this assignment, the two consultants conducted personal interviews with many individuals in the Ministry of Agriculture and other institutions who were engaged in extension, research and teaching

at the national, provincial or divisional level. They also reviewed all relevant documents, including the RFCP Project Paper, briefing papers, evaluation reports, etc., and discussed their assignment with USAID personnel who were working with the Ministry of Agriculture or were specifically concerned with agricultural projects.

From the results of their interviews and review of documents, Hunter and Teetes concluded that the RFCP project was not appropriate to most of the agriculture in the Cameroon, stating that the environmental conditions of the Sahelian countries involved in the project were only marginally related to those in the Cameroon. Furthermore, they believed the RFCP project itself was overly ambitious, poorly designed and poorly managed by USAID/Yaounde. Despite this, they considered that USAID/Yaounde had contributed significantly to the development of CREFPHY by providing physical facilities, resources and advanced training for its Director, commenting that its training activities had met with some success. They also stated that USAID/Yaounde is interested in developing a bilateral food crop protection project with the Cameroon government; this IPM Pilot Project would be implemented as outlined in the Glass/Goodwin report.

The two men related that the Cameroon government had recently acknowledged that much more emphasis must be placed on food crop production and protection so that the country could remain self-sufficient in food production. They asserted also that the government recognized the need to train extension workers and farmers in food crop production and protection practices and was cognizant of the important role CREFPHY could play in this training. Coordination of teaching, research and extension activities was difficult, however, because the organization of the government had

resulted in the responsibilities of agricultural activities being assigned to several institutions.

At the end of their report, the team reviewed several options which they felt were open to USAID with regard to CREFPHY:

1) USAID could terminate their support at the end of the current RFCP project in September, 1984,

2) they could continue their present level of support,

3) responsibility for training could be transferred to other government institutions,

4) crop protection specialists at the Agricultural Research Institute could be used to train extension personnel,

5) CREFPHY could be developed into a National Crop Production Training Center for extension workers, or

6) CREFPHY could be developed into a National Crop Production and Crop Protection Training Center for extension workers.

After examining the advantages and disadvantages of these six options, the two men made it clear that the development of CREFPHY into a National Crop Production and Crop Protection Training Center for Extension Workers was the option they favored. Having indicated this, the team proceeded to discuss a possible scenario of events which would be required to bring about the development of this center. This scenario included a recommendation that CREFPHY be strengthened to improve its capability to provide in-service training of extension personnel in the concepts and practices of IPM, especially at the local level. This would be accomplished in three phases: Phase I would include training of extension workers in the IPM Pilot Project for a period of five years and evaluating their ability to apply their training. The Training Officer and the Director of CREFPHY

would be expected to work with the Country Project Officer and the Chief of Base to ensure coordination between training and implementation of the IPM project. If Phase I is successful, Phase II would include the development of a National Crop Protection Training Center for extension workers. If this latter phase were also successful, Phase III would expand this center to include training in both crop production and crop protection. Such a center could be integrated into any research, extension or educational organization to develop a cadre of crop protection expertise.

Another important recommendation was that a new sub-department entitled "National Agricultural Extension Training Center" (currently CREFPHY) be established in the Department of Agriculture, in a central position between the Sub-Departments of Agricultural Production and Crop Protection. They believed that a clearly defined position in the Department of Agriculture would improve coordination of agricultural training activities by other government organizations and international projects operating in the Cameroon, better disseminate the results of research to the extension workers, and would ensure equal emphasis in training extension production personnel in the prevention of pest/disease problems and crop protection specialists in intervention practices with pesticides. The team stressed the importance of hiring only the best qualified and best motivated crop protection scientists to accomplish the goals and objectives of CREFPHY. The two men also recommended that a Provincial Advisory Board for CREFPHY be established to ensure that the training needs of the extension workers at the local level are made known to the Sub-Director of CREFPHY and the Director of the Department of Agriculture.

As had been requested, the team developed specific work plans, resource needs, and job descriptions and qualifications for CREFPHY personnel, which were given in detail in their report.

A final recommendation concerned the possible collaboration between CREFPHY and the Extension Component of the National Cereals Research and Extension Project (NCRE). Hunter and Teetes felt that such a relationship would be beneficial since maize, one of the crops to be included in the IPM Pilot Project, is one of four cereal crops in the NCRE project, and information that might be needed by CREFPHY on the protection of that crop would be available through the Agricultural Research Institute (IRA) scientists responsible for research in the NCRE Project. Other aspects of this collaboration could include interaction between CREFPHY and NCRE extension personnel and a sharing of teaching responsibilities; participation as demonstrators in short courses by NCRE scientists conducting maize trials in the same area where CREFPHY short courses on pest/disease problems of maize will be taught; and provision of literature sources for CREFPHY instructors.

The team emphasized that evaluation of the ability of CREFPHY to provide in-service food crop protection training for extension workers participating in the IPM Pilot Project will be very important. They recommended an internal evaluation annually and a comprehensive external mid-term evaluation. During the last year of Phase I, there should be a comprehensive review to determine if success had been sufficient to warrant expansion into Phase II.

Although not in their original assignment, the team was asked to give their opinion on the role and capacity of the Diagnostic Laboratory for meeting the needs of food crop farmers and its relationship to CREFPHY.

They determined that because they serve the same clientele and would benefit by sharing resources and professional expertise, there would be many advantages for the two organizations to be linked administratively and functionally, and the team provided in their report a list of major resources needed for the laboratory to complement the activities of CREFPHY.

Regional Project in Integrated Pest Management, Central America and Panama, January 22 - March 9, 1984

Following the introduction of integrated pest management (IPM) concepts to Central America in the late 1960's, widespread interest and support for a regional project in IPM gradually increased until in May 1983 such a project was formally proposed to USAID in a Project Identification Document (PID) prepared by a team of CICP consultants. This document was accepted and approved by the Agency which then invited CICP to organize a multi-disciplinary team of scientists to design the project and prepare a Project Paper (PP). The individuals selected to form this team were: Dale G. Bottrell, entomologist, University of Maryland; Harold D. Coble, weed scientist, North Carolina State University; Frederick C. Fliegel, sociologist, University of Illinois; Virgil H. Freed, pesticide chemist, Oregon State University; Jennifer Kogan, information specialist, INTSOY, University of Illinois; George A. Niles, agronomist, Texas A&M University; Katherine Reichelderfer, agricultural economist, U.S. Department of Agriculture; and H. David Thurston, plant pathologist, Cornell University. In order to analyze the requirements for the proposed project, this team of experts, during the six week period indicated, consulted with representatives of USAID missions, the Centro Agronómico Tropical de Investigación y Ensenañza (CATIE), national Ministries of Agriculture, national

universities, agricultural schools, U.S. Peace Corps, other regional and international institutions, and the private sector in Costa Rica, El Salvador, Guatemala, Honduras and Panama. The information they obtained in field visits and reports, bulletins, project documents, and other information which was made available to them formed the technical basis for the design of the project.

The purpose of this project is to strengthen the regional and national institutional capability for crop protection in Central America and Panama and to help establish sound integrated pest management programs aimed at decreasing the deleterious effects caused by pest organisms to the major crop production systems in the region as well as reducing the negative environmental impact of the pesticides used for their control. The project was proposed in the belief that a key obstacle to increased agricultural output in the Central America and Panama (CA/P) region is the inadequacy of crop protection measures to control pests. An examination of the pest control situation showed that for most small farmers there are no organized methods of crop protection. Some farmers simply tolerate pests or rely on natural forces to control them. Other farmers may rely on chemical means of control, but there were few CA/P farmers able to properly diagnose pest problems or apply pesticides correctly and safely. The present project was proposed as an effort to help the CA/P farmer increase crop production, yields and earnings while at the same time reducing health and environmental hazards associated with crop protection programs based heavily on pesticides.

As one of its principal objectives, the project will establish and maintain a centralized regional source of technical services and information at CATIE in Turrialba, Costa Rica. This service will be capable of

assisting the national and regional institutions with integrated crop protection activities. Other objectives of the project are: (1) to develop and analyze a profile of pest perceptions which could be used to establish priorities for national, bilateral and regional IPM research and educational programs; (2) to create an awareness among national institutions and personnel for the need to determine the general losses caused by major pests and to promote appreciation of the usefulness of this information for providing more appropriate guidelines for control of these pests to farmers; (3) to train directly, or provide the means for training, a significant number of regional and national technical personnel through the presentation of short courses and seminars at CATIE and selected national level field sites; and (4) to establish an identification and diagnostic service at CATIE, assisted by a network of crop protection extension personnel which would provide the capacity for positive and timely identification of exotic and native pest organisms.

In their discussion on the rationale for a regional approach to attack the pest management problems of Central America and Panama, the team pointed out that no one country in the region has sufficient specialists trained in crop protection to develop and implement effective national IPM programs in research, training, and technical cooperation; and, in their view, adaptive IPM research and specialized training can be provided more effectively through a regional project because of the regional commonality of many pest problems and cropping systems, and the relatively limited resources of the individual countries.

The Tropical Center for Agricultural Research and Training (CATIE) was selected as the implementing institution because its regional character allows it to function relatively free of the economic and political

constraints that usually affect national institutions. Furthermore, the design team considered that it had the institutional capacity to develop and implement the regional IPM project because of its previous experience in implementing the small farm production systems project and its well-established infrastructure and capacity for research, training, and information management. The project will be implemented by CATIE's Department of Plant Production under the direction of the IPM Project Manager who will head a team of IPM specialists and technical support personnel. This team will form a core of expertise at CATIE to carry out research, serve as instructors for training activities, provide technical assistance and coordinate all project activities. The team will consist of an IPM specialist who will serve as team leader with overall responsibility for coordinating project implementation; an entomologist who will also be the coordinator of pesticide research activities; a plant pathologist who will be responsible for pest diagnosis services; a weed scientist/agronomist who will coordinate training activities; an information specialist and an economist. In addition to this team, the project will place a coordinator in each of the five participating countries to serve as the link between the national institutions and the project staff at CATIE.

The project paper provides a comprehensive statement and explanation of the initiatives and steps that will be followed in order to strengthen the capacity in the region for implementing integrated pest management projects, and in the interest of providing a more complete understanding of the scope and intent of this project, an abbreviated discussion of its principal components follows. As previously stated, the regional IPM project is intended to promote an improved state of understanding of the concepts and application of integrated pest management in CA/P, especially

as related to small scale producers of food and cash crops. The approach to this broad objective is focused on three components: research, training and technical cooperation. These three complementary and overlapping components have been designed to meet the region's needs in establishing IPM as an important element in agricultural production, and each includes activities which respond to the concerns identified by the Project Paper design team after it had discussed the proposed project with public and private sector individuals throughout the region.

The research component intends to identify and test IPM practices applicable to small farmers and will build on the experiences of the ROCAP-financed small farm production systems project with emphasis on the development of optional IPM schemes which fit CA/P farming systems. Much of the research will be based on existing technologies and will be carried out both at CATIE and on selected farms in the participating countries. The impact and effectiveness of the research will be strengthened by linkages with several national institutions, such as the Instituto de Ciencia y Tecnología Agrícola (ICTA) and the Dirección General de Servicios Agropecuarios (DIGESA) in Guatemala; the Programa Nacional de Investigación Agrícola (PNIA) and the Escuela Agrícola Panamericana (EAP) in Honduras; the Centro Nacional de Tecnología Agropecuaria (CENTA) and the Dirección de Defensa Agrícola (DDA) in El Salvador; the Ministerio de Agricultura y Ganadería (MAG) and the Universidad de Costa Rica (UCR) in Costa Rica; and the Instituto de Investigación Agropecuaria de Panamá (INIAP) and the Universidad de Panamá in Panama.

The research activities which are planned for this project involve three areas: (1) crop loss assessments to identify the most important pest problems of the selected crops; (2) approaches and methods of IPM,

including the appropriate use of pesticides; and (3) socioeconomic research to identify constraints to transferring IPM technologies in the region. To initiate the crop loss assessments, the project will sponsor a regional workshop during the first year to which the region's experienced crop protection specialists will be invited. Among the approaches and methods in IPM, priority areas include: the efficacy of combining cultural control methods and host plant resistance for control of Black Sigatoka of plantain; the yield-improvement effects of the traditional "tapado," or "covered bean," system for weed and disease control in beans; the efficacy of biological control agents (pathogens and parasites) of lepidopterous pests of maize, etc. In the undertaking of socioeconomic research, appropriate socioeconomic variables will be examined to measure the acceptability of the pest management technologies developed and tested under the project.

In their consideration of the training needs of the area, the CICP design team stated that training of extensionists, researchers, teachers, public and private sector officials, and farmers is essential to the successful development and implementation of IPM practices. In their view, training must be especially tailored in order to communicate the principles and applications of IPM to different audiences. Thus, practical, field-oriented training is required for extension officers and others working in IPM implementation at the farm level, whereas highly technical short-term training is required for researchers and those in charge of developing specialized programs such as pest diagnosis and pesticide management. The large scale extension of training to farmers would be the responsibility of the national institutions collaborating on the project while the CATIE staff will conduct special training activities when a specific need is

identified. A series of 42 seminars and workshops directed at a broad audience were tentatively planned and will be presented for one day to two weeks in-country, primarily in order to maximize participation and minimize costs. For the seminars and workshops held in the third and fourth years of the project, initial results from research activities will be available to demonstrate the impact of IPM. In the final year of the project, a wrap-up seminar will be held in each country to provide the target audience with more detailed results from project-sponsored research.

The objective of the technical cooperation component is to establish the capacity at CATIE to provide services in IPM to public and private sector institutions and individuals in CA/P. The services involved are a pest identification and diagnostic service which is aimed at increasing regional and national capabilities in pest identification and diagnosis; a regional IPM information service consisting of a center established at CATIE to organize and distribute information needed to augment IPM research, training, and technology transfer in the region; and technical assistance services aimed at providing short-term assistance in IPM practices to national institutions, including private sector individuals or groups. Each of these services will be integrated into and synchronized with the research and training components of the project.

The regional pest diagnostic service center will be staffed by the project-funded IPM specialists who will provide a centralized source of diagnostic expertise capable of responding to requests from national institutions. Among specific tasks of this center are: conducting initial and follow-up training for national diagnosticians and assisting in the organization of a network of national centers; establishing and maintaining reference collections for the important pests of the principal crops in the

region; and cooperating with crop loss assessment research efforts by providing information on crop pest incidence by geographic area or cropping systems. By utilizing existing laboratories in the participating countries, the project will also establish a network of pest diagnostic centers in the region to be linked to the Regional Pest Diagnostic Center at CATIE. The regional IPM information service center will also be headquartered at CATIE and will coordinate such activities as: the development of a computerized IPM information base; the provision of an information search and referral service, and the provision of training and tec[illegible]ssistance in literature searching and documentation.

With respect to the technical assistance to be provided by the project, the project staff, supplemented by short-term consultants, will provide technical assistance on specific tasks required to facilitate regional and national IPM program development, implementation and evaluation. This assistance will be initiated in response to specific requests which, typically, will be received by the country coordinator and passed on to the IPM team at CATIE. The provision of services under this component will be coordinated by the entire IPM team with the plant pathologist having primary responsibility for the pest diagnostic services while the service center will be coordinated by the information specialist. All members of the team will provide technical assistance as appropriate and, in those cases where project staff do not have the technical proficiency to provide requested services, specialized short-term assistance will be obtained from qualified consultants.

The proposed budget for the project is $7.5 million, of which ROCAP will contribute 90% and CATIE 10%. This funding will cover activities planned over the implementation period of five years from January 1985

through December 1989. The Agricultural Development Office of USAID's Regional Office for Central American Programs (ROCAP) in Guatemala will have primary responsibility for managing the project for USAID. CICP has a Regional Pest Management Specialist in Costa Rica assigned to that office, and he will serve as the project technical coordinator with day-to-day responsibility for monitoring the implementation status of the project. Several evaluations of this IPM project are planned, including two formal evaluations scheduled for the 26th and 42nd months of project implementation. These evaluations will be conducted to examine the progress of activities under each project component, the appropriateness of the training being provided, the quality of communications developed, the effectiveness of the national IPM work groups, the extent to which national institutions are capitalizing on CATIE's technical services capabilities, and the management of the project.

Agriculture Research and Development Project, Burma, August 22 - September 10, 1984

In May 1982 CICP consultant, Edward H. Glass, entomologist, Cornell University, visited Burma to perform an environmental analysis of pesticide use and to incorporate IPM techniques in the design of a Maize and Oil Crop Production Project. During the period under discussion, he returned to Burma to serve in a similar capacity on the Project Paper (PP) design team of the Agriculture Research and Development Project, whose major goal is to increase the productivity of maize and oil seed crops in its initial stages and later, that of other crops. The three principal components of the project are: (1) research organization, planning and implementation, (2) research training, and (3) improvement of research facilities.

In addition to Dr. Glass, the design team included specialists in agronomy, water management, sociology, training, environmental issues and project development. As the team's integrated pest management (IPM) specialist, he was assigned the following tasks: writing an environmental soundness statement (together with the USAID Regional Environmental Officer); examining IPM as an alternative to imported pesticides and writing a statement for the Project Paper recommending IPM research methodologies and projects; preparing a list of the major pests of both maize and oil seed crops and recommending a research program to address these problems; and preparing a list of commodities and amount of technical assistance needed to implement the proposed research program and IPM project.

The methods used by the CICP consultant to identify the major crop protection problems in the country were: (1) interviews with knowledgeable people in Rangoon, (2) a study of available publications and reports on pest problems, and (3) field observations and interviews with field and Agricultural Research Institute personnel during a week of travel from Rangoon to Mandalay. Nevertheless, some of the conclusions and recommendations in his report were based on his previous experience in Burma in 1982 as he found it impossible in such a large country to make a survey of these problems in two weeks.

In terms of losses caused and lack of technology for their management, he stated that it appeared that rats are the major pest problem in Burma. Severe losses in the field and in storage were recorded for rice and food crops and researchers reported that they were unable to obtain reliable yield data from experimental plots because of extensive feeding by rats; Glass himself, observed an estimated 75% loss of a mung bean crop caused by rats in a planting in an irrigated area south of Mandalay. To improve

the situation, he recommended that the system of managing rats in farmer's fields developed by the National Crop Protection Center in the Philippines be evaluated as it had not yet been tried in Burma.

A second major crop protection problem cited in his report was weed control during the monsoon season. He stated that it was impractical, if not impossible, to control weeds by hand or mechanically in sown crops during continuous heavy rain periods, and the use of herbicides would not be appropriate for extensive small farmer use because of their cost. During their stay, the design team observed numerous plantings in farmer's fields where weeds were as tall as the crop and were estimated to be reducing yield by 40-50%. He concluded that a strong research program in weed science was essential for developing suitable weed management techniques, especially for the rainy season.

Glass expressed surprise that most Burmese interviewed stated that insect pests were not major problems on maize, oil seed crops and rice; however, on further questioning, he found that groundnuts and sesamum are regularly sprayed two to four times with insecticides to control insect pests. In fact, sesamum was considered a poor choice for oil production because of losses caused by insects and a plant disease transmitted by jassid insects. After reviewing insect problems on several other crops and the poor state of knowledge in biological and cultural controls and host plant resistance, he declared that a strong research program in insect pest management was essential to improve present control technology and that Burma provided an opportunity to develop integrated pest management programs before major secondary pest and insecticide resistant problems develop.

With regard to plant diseases, Glass found that diseases on oil seed crops were devastating during the monsoon season. In the heavier rainfall areas, these crops are grown only in the early monsoon weeks or post-monsoon following rice on residual soil moisture. He gave examples of several diseases and their impact on sesamum, sunflower and groundnuts and cited the need to survey, identify and determine yield losses caused by numerous as yet unidentified pathogenic microorganisms. He felt that a major effort should be made in conjunction with plant breeders to incorporate resistance into useful cultivars.

When considering the existing number of trained scientists in crop protection, he noted that they were in extremely limited supply and will continue to be so over the next few years. He therefore felt it was imperative that a strong training component in these disciplines be included in the project, and he also recommended the short term training of mid-career scientists as a means of improving the situation in the near term. Upon examination of research facilities, he found that the laboratories for entomology and plant pathology appeared to be adequate for the near future, although the latter needed additional items and entomology would require considerable equipment to backstop future research programs.

In summarizing the general crop protection situation in Burma, Dr. Glass stated that the present and projected efforts to increase agricultural productivity will result in adoption of the high yielding technologies that have in most instances increased pest problems in other countries. Severe losses have often occurred in these countries before suitable integrated pest management techniques could be incorporated with the new

practices, and he expressed the view that a strong IPM research and development effort was needed in the Agriculture Research and Development Project to avoid such occurrences.

TRAINING ACTIVITIES

PESTICIDE SAFETY WORKSHOPS

LESOTHO AND ZAMBIA

Pesticide Handling and Application Workshops in Lesotho and Zambia, August 13-15, 1984, and August 22-24, 1984

Two workshops were sponsored by USAID, CICP, and the International Plant Protection Center (IPPC) of Oregon State University to provide training in the fundamentals of safe handling and accurate and efficient application of pesticides. Dr. Alan S. Cooper of IPPC, sponsored by CICP, and Janice Jensen, USAID/REDSO/Kenya Regional Pesticide Adviser, were major instructors in the workshops.

Trainees in both three-day workshops represented backgrounds ranging from store managers to researchers, as well as managers of government-run co-ops distributing pesticides to farmers. Instruction included a combination of classroom lecture-discussion sessions and field exercises. Familiarization and calibration of lever-operated knapsack sprayers, and pesticide rate calculation exercises were a major area of concentration during the workshops, as was safe handling and use of pesticides. Special lectures on types of chemicals available in each country and their levels of pesticide toxicity were offered by guest speakers from Shell Chemicals Ltd., Mt. Makulu Research Station in Zambia, and the Garden Center and Co-op Lesotho in Maseru.

Thirty-one trainees participated in Lusaka, Zambia, where the workshop was held at the Natural Resources Development College. At the Anglican Training Centre in Maseru, Lesotho, thirty-six individuals participated. The high professional and academic levels of the trainees made the discussions and field studies interesting and stimulating for both the participants and instructors.

The consensus among participants and instructors was that, because of the steady increase in the use of pesticides in both areas, this type of guidance is crucial to the healthy future of agriculture. Trainees in both countries agreed that future courses should be longer to permit more time for review of different types of sprayers, pesticides and spraying situations, with additional time allowed for actual field trials.

It was observed that through participation in the workshops a network of professional contacts was established among individuals representing the various groups involved. Careful pre-course selection of trainees is very important as a basis for achieving this goal.

Follow-up surveys are planned to assess the extent to which the material presented is being extended at the regional and district levels.

REGIONAL PEST MANAGEMENT SPECIALIST ACTIVITIES

TECHNICAL ASSISTANCE

REGIONAL IPM PROJECT
(CENTRAL AMERICA AND PANAMA)

Regional Pest Management Specialist Activities in Central America and Panama

Through a cooperative agreement negotiated with USAID's Bureau for Latin America and the Caribbean, CICP has based a Regional Pest Management Specialist (RPMS) in Guatemala since January 1980 for the purpose of advising and assisting ministry officials and plant protection workers in El Salvador, Guatemala, Honduras, Nicaragua, Costa Rica and Panama in the development and implementation of pest management and crop protection programs. The present RPMS, entomologist Angel A. Chiri, assumed the position in September 1982 and, like his predecessor, was assigned to USAID's Regional Office for Central American Programs (ROCAP). As a result of a decision by ROCAP to initiate and fund a regional project on integrated pest management, Dr. Chiri's duties in his first year were, to a great extent, devoted to collecting pest-related information needed for the planning of this project and also to establishing vital lines of communication and collaboration between both public and private institutions and individuals concerned with pest-related problems in order to enlist their cooperation and support for the proposed regional IPM project.

In May 1983, the RPMS met with a team of CICP consultants and personnel of the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) in Turrialba, Costa Rica to discuss the concept, design and implementation of the proposed five-year ROCAP/CATIE Regional Project in Integrated Pest Management and to prepare a Project Identification Document (PID). Following approval of the PID on October 28, 1983, CICP organized an eight-member project design team which visited Central America and Panama, as described in an earlier section of this report, in early 1984

for the purpose of preparing the Project Paper. In preparation for the team's visit, the RPMS travelled extensively within the region to discuss the proposed IPM project with plant protection officials of national and regional institutions and to schedule meetings and interviews for the team with key individuals. After the team's arrival in Central America, Chiri continued to take an active part in various aspects of the project design process and on several occasions he joined the team as they visited different countries of the region. A brief review of his meeting with plant protection personnel in El Salvador in advance of the design team, and a report of his participation in the team's activities during visits to El Salvador, Honduras and Costa Rica follows.

From January 16-18, 1984, Chiri visted El Salvador to meet with officials of USAID's Rural Development Office and to discuss the planned two-day visit to that country by several members of the regional IPM project design team. He also met with technical personnel of the national cotton IPM project to brief them on the purpose of the team's forthcoming visit. On this and a subsequent trip, he was informed that certain people had to be convinced of the importance of the project and that the team should meet with these persons to enlist their support. During the period January 30-February 2, the RPMS accompanied the design team in Costa Rica to meet the staff of CATIE's Plant Production Department and obtain information about their individual and collective research and teaching experience, and also to record their comments, suggestions and reactions concerning the regional project. Among the major issues that emerged from these interviews was a general concern for the new responsibilities the project would present to the staff inasmuch as they felt their time was already fully occupied with their present responsibilities. They also

expressed certain concern about the ability of the existing CATIE facilities to accomodate the new project staff and restated their view that the project should focus on cropping systems that include maize, beans, rice and sorghum. They also suggested that the process of selecting specific pilot implementation sites should be the same as or similar to that used in the small farm production systems project.

During the week of February 7-11, Chiri went to El Salvador and Honduras with the CICP/ROCAP design team to identify potential areas of collaboration with crop protection programs and organizations in those two countries. In discussions with El Salvadoran officials, it was learned that their country could not make a counterpart contribution to the project because of its financial crisis and the already large number of existing projects it was implementing. However, the team assured these officals that their ideas and suggestions would be considered to the fullest extent possible in the design of the regional project. Centro Nacional de Tecnología Agropecuaria (CENTA) officials also told the team that any project activities planned for El Salvador must fit within their country's existing program structure. The director of CENTA's research division identified three areas in which the regional project could assist their crop protection efforts, to wit: (1) short-term training in specific areas, (2) financial support for technical publications and inter-country transfer of information, and (3) identification of insect and weed pests at the species level.

In Honduras, possible links with the regional project that were discussed with personnel of the Escuela Agrícola Panamericana (EAP) included: (1) sponsorship and collaboration in the presentation of practical short courses, (2) access to technical information, (3) support for

attending regional meetings, and (4) establishment of pesticide management programs. The director of the school was specifically interested in increasing EAP's involvement in international research and training programs in agriculture.

The RPMS returned to Costa Rica from February 16-18 to meet with the IPM design team and members of CATIE's Plant Production Department staff again and hold discussions about the progress in project design activities. Among the recommendations presented by CATIE's staff at their meeting were the following: (1) they felt the regional project should be considered an extension of the small farm production systems project, (2) the links already established by CATIE with CA/P countries should be maintained, (3) the country coordinator should not be attached to any national institution, (4) the project should provide the means for CATIE to contract IPM specialists in areas where it lacks expertise, and (5) project efforts in all participating countries should be centrally coordinated by CATIE. During the briefing session the design team presented to USAID and CATIE staff, it was evident that considerable progress in diverse areas had been made and that many elements of the project's three components had been identified. Areas identified as possible research and training targets were: postharvest pest losses in basic grains; control of Black Sigatoka on plantain; pesticide management; chemical and cultural weed control; and crop loss assessment. The training component was being designed to emphasize short-term training and linkage with other training institutions in Central America and Panama. The involvement of Peace Corps volunteers in this area was seen as highly desirable, and it was also recommended that the expertise of private industry in specific areas should be utilized.

From February 22-26, Chiri again went to Costa Rica to attend a meeting in which design team members discussed and reviewed their accomplishments up to that time before the arrival of USAID officials from Washington, D.C. and CICP's Executive Director who had come to Turrialba for that purpose. The team explained in detail the project design process and the results obtained, emphasizing the technical aspects of the project's three components. Much of their discussion centered on the proposed project personnel and their duties and on the objectives of the research component. In separate discussions between the RPMS, CICP's Executive Director and USAID officials, it was decided that the RPMS would serve as the technical coordinator for the project for USAID, with day-to-day responsibility for monitoring the implementation status of the project. Further agreement was reached that the RPMS should allot 50% of his time to these oversight duties and, for this purpose, it was concluded that the base of operations for the RPMS should be transferred from Guatemala to Costa Rica.

TRAINING AND QUALITY CONTROL PROGRAM IN PESTICIDE RESIDUE ANALYSIS

MIAMI

University of Miami Training and Quality Control Program in Pesticide Residue Analysis

Training and technical assistance activities in pesticide management (agromedicine) continued in the Department of Epidemiology and Public Health at the University of Miami in Florida. Originally established in 1974 under a subcontract agreement with CICP's predecessor organization, an important part of this activity is the management of a quality control program to develop and maintain uniform standards of operation among a network of analytical pesticide residue laboratories in developing countries. To permit effective management of the program, participation in this network is restricted to 45 laboratories. Every few months, each participating laboratory receives a sample containing a mixture of pesticides with instructions to analyze it, using methodology suggested by the University of Miami. Laboratories are requested to report the identification of all pesticides present and to determine the amount of each chemical present. Other methods could be used by the laboratory chemists so long as they specified the method used. The results reported are subjected to statistical analysis and a critique and evaluation is then sent to responding laboratories in order to help them improve their performance. A coding system preserves the confidentiality of the participants' identity.

During the reporting period, two quality control samples were formulated and mailed to each of the participating laboratories. Twelve (12) labs reported results for sample UM-016 and thirteen (13) reported on sample UM-017. The director of the quality control program then sent an evaluation to each laboratory, along with the overall statistical results,

to allow each lab to compare its performance with other participants in the program.

It was discovered early in the program that training in pesticide analysis was of prime importance, to provide practical knowledge in sample extraction and clean-up, use of analytical equipment and identification/quantitation, pesticide safety practices and basic information on the chemistry of herbicides, fungicides and insecticides and their influence on the environment. In 1977, the first training course was instituted by the personnel in the Department of Epidemiology and Public Health for individuals selected from participating laboratories, with at least two courses offered each year thereafter. These courses are advertised among the participating laboratories and the related USAID country missions, so that qualified trainees may be named. During the period of this report, two courses were offered in pesticide residue analysis. The first, from June 18 to July 6, 1984, gave training to seven chemists, four from Jamaica, two from Belize and one from Costa Rica. The second course during the period September 17 to October 5, 1984, provided training to two chemists from Trinidad, and one each from Brazil, Colombia, Honduras and Jamaica. Two additional courses were planned for the first six months of 1985 with anticipated trainees from Honduras, Bolivia, Dominican Republic, The Philippines and Grenada.

As discussed elsewhere in this report, among the recommendations made by a team of four CICP consultants who conducted a technical review of the proposed use of Temik® for the control of the cotton whitefly, Bemisia tabaci Genn., in the Gezira and Rahad projects in the Sudan, were the establishment of a two-man biological monitoring team and a three-person health and environmental team to undertake studies needed to determine the

fate of residues of Temik® in the environment. J. Bruce Mann, chemist and director of the quality control program at the University of Miami School of Medicine, along with Joseph Danauskas, field epidemiologist, also in Miami, were members of the latter team and conducted analyses of various samples at the laboratory in Miami.

PUBLICATIONS

The publications of the Consortium are principally printed materials containing the results or proceedings of short courses in integrated pest management, seminar/workshops in pesticide management and special reports. Except for a small number of priced publications, these materials are distributed free upon request to interested individuals. The Consortium also distributes a quarterly list of international conferences related to pest management.

APPENDIX

SUMMARY OF OVERSEAS ACTIVITIES OF CONSULTANTS AND PROJECT PERSONNEL

OCTOBER 1, 1983 - SEPTEMBER 30, 1984

September 10 - November 21, 1983	Hodge Black, Joseph Danauskas, Donald Morgan, and Geoffrey Zehnder - Carried out biological and health monitoring of effects of applications of Temik® on cotton in the Sudan.
September 19 - October 18, 1983	Patricia Matteson - In Niger worked with the Niamey Department Development Project on design of better crop protection extension program.
September 26 - October 24, 1983	Harvey Reissig - In the Philippines discussed IPM programs for rice with IRRI personnel. Assisted USAID/Bangkok in crop protection matters and in preparation of a risk benefit analysis and a methodology management program.
November 16-25, 1983	Ray F. Smith - Attended International Congress of Plant Protection in Brighton, England.
December 5-22, 1983	Donald Calvert and Carroll Collier - Assisted in the preparation of an environmental assessment involving a large purchase of pesticides by USAID/La Paz, Bolivia.
January 8-19, 1984	James Grieshop - Met with officials at USAID/Quito and others in agricultural disciplines to discuss training activities in crop protection.
January 10-20, 1984	Gunther Zweig - In Washington, D.C. and Madison, Wisconsin, prepared "Environmental Assessment and Exposure Analysis for the Use of Creosote and Inorganic Arsenicals for Wood Treatment Plant," to be used by AID project in Upper Volta.

January 22 - March 14, 1984	Dale Bottrell, Harold Coble, Frederick Fliegel, Virgil Freed, Jennifer Kogan, George Niles, Katherine Reichelderfer and David Thurston - Performed necessary work related to the preparation of a RCCAP Project Paper on the development of a regional integrated pest management project for Central America.
February 3-10, 1984	Diane Raines - Worked with officials at USAID/San Jose and others in Costa Rica on techniques for the analysis for pesticides in water. Stopped in Miami to discuss long-term linkages between Costa Rican chemists and the Miami pesticide residue analysis training facility.
February 7-12, 1984	Gary Simone - Assisted an AID program in Belize in identifying the cause of severe loss in production of melons in Northern Belize.
February 12-22 and February 26 - March 8, 1984	George Cavin - Participated in meetings with USAID personnel from Caribbean basin countries to discuss economic impact and regulatory problems associated with EDB fumigation of tropical fruits and citrus plants.
February 22-26, 1984	George Cavin and Joseph Cummings - Met with USAID personnel from Caribbean basin countries to discuss the impact of EDB fumigation of tropical fruits and citrus plants.
April 9-14, 1984	Joseph Cummings - Coordinated the technical work for the analysis of EDB in papaya and mango at the USDA/ARS laboratory and the University of Miami School of Medicine, in connection with shipments from Central America.
May 23 - June 16, 1984	Mike Irwin - Worked with Integrated Crop Protection Commission and others in the continuing development of IPM programs in Ecuador and Peru.
May 31 - June 20, 1984	Hal Reynolds - In Kenya, discussed with REDSO/ESA and others associated with AID in Nairobi future planning for pest and pesticide management activities in East Africa. At FAO/Rome and at the International Pest Management Centre in Silwood Park, England, met with scientists and officials

to discuss other IPM matters associated with East Africa and other regions.

June 11-22, 1984

Fowden Maxwell - Represented AID at the Host Plant Resistance Short Course in Nairobi and assisted in the redesign of the Basis of Plant Resistance Project.

July 5-14, 1984

Ray F. Smith - In Costa Rica, held discussions with officials of ROCAP and CATIE, among others, regarding future CICP activites and networking. In Chile, participated in Biological Control Round Table and discussed crop protection networking in South America with representatives of various organizations. Met with personnel of USAID/Lima, CIP, INIPA, UNA and the Peru ICP commission to discuss matters concerning CICP's future activities and networking in Peru.

July 24, 1984

Joseph Cummings - Met with Costa Rican chemists to discuss pesticide residue problems in coffee.

August 3-29, 1984

Alan Cooper - Participated as a trainer in short courses on "Safe Pesticide Use and Effective Application" in Lesotho and Zambia.

August 18 - September 5, 1984

Ray F. Smith - Attended XVII International Congress of Entomology in Hamburg, Germany; met with Gustav Mathys (OEPP/EPPO) and others in France to discuss pest management activities.

August 23 - September 6, 1984

Edward Glass - Crop Protection Specialist on Burma Agricultural Research and Development Project Paper Design Team.

September 4-6, 1984

Ken Hagen - Participated in the First Regional Symposium on Biological Control in Kuala Lumpur, Malaysia.

September 9 - October 2, 1984

Dale Bottrell - Performed an Environmental Analysis/Risk Assessment for the establishment of a Pest Management Unit in the Grenada Ministry of Agriculture, and provided analysis and recommendations regarding other aspects of the proposed unit.

September 15-19, 1984	Brenda Mosley - Assisted the Ministries of Agriculture and Health in the initiation of a program to disseminate information on agrochemicals in Panama, and to develop direct linkages in Panama to the resources in the U.S. National Agricultural Library.
September 16-20, 1984	Perry Adkisson - In Algeria, represented CICP and USAID at the "Conference on Integrated Crop Protection and Rationalization of the Use of Pesticides in Agriculture in the Arab Region," sponsored by the Arab Organization for Agricultural Development. Dr. Adkisson presented a talk on "The Development of Integrated Crop Protection in the Arab Region and Its Potential Impact on Pesticide Usage."
September 19 - October 5, 1984	George Cavin - In Mexico, worked with Sanidad Vegetal and USDA personnel to test alternate fumigants for EDB and to evaluate growth regulators for preventing development of fruit fly larva in fruit.