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East Asian Pest Management

Study Team Report

Contents

SUMMARY

Populations in most of the tropical countries of East Asia will double in about twenty years. Improved crop protection can do nothing to reduce the population explosion, but it can make important contributions towards assuring an adequate food supply until populations become stabilized through family planning and birth control.

A study team composed of an entomologist, a plant pathologist, a nematologist, and a weed scientist spent 40 days visiting the Philippines, Thailand, Malaysia, Taiwan, Hong Kong, Singapore, and Japan in order to appraise the nature and scope of pest problems affecting the food supply in these countries. They also attempted to determine whether the local environment and public health are endangered by improper use and lack of management of pesticides on food and other major crops.

Pest management systems in tropical East Asia range from the highly sophisticated to the primitive, but in general, considering the magnitude of the problems, crop protection practices are inadequate or not well conceived. The increased yields of the green revolution are based on the widespread use of a small core of germplasm, larger plant populations per hectare, increased use of fertilizer, increased pressure to obtain two - three crops per year from the same land, more widespread use of irrigation, and improved cultural methods. It is paradoxical and unfortunate that often these practices increase the chances of serious attacks by pests and pathogens. The tungro virus disease epidemic on rice in the Philippines is an excellent example of this principle. The intensification of agriculture in East Asia has also produced new problems such as pesticide resistant strains of insect pests, pesticide residue problems on certain crops, and changes in the relative importance of pests on major food crops. Some general deficiencies in crop protection

identified are: 1) inadequate information on losses due to pests, 2) economic thresholds for pests are not established, 3) applied research is inadequate on most food crops in most countries, 4) extension activities are inadequate in most countries, 5) pesticide regulations are out of date or inadequate, 6) there is almost no monitoring of pesticide residues on edible crops, and 7) post-harvest losses are seldom being studied or controlled.

There is a serious lack of trained manpower for crop protection activities, and the existing manpower needs to be used by governments with greater efficiency. The research emphasis is too often concentrated on organisms as objects of scientific curiosity in the laboratory and not on the solution of practical problems as they exist in farmers' fields.

The insects, diseases, nematodes and weeds of major importance in East Asia are given in the appendix. Most major insect and disease problems in East Asia have been identified, but in most countries considerable work needs to be done in further identification of nematode and weed problems. Specific suggestions were made for the improvement of library deficiencies, lack of books on tropical pest management, pesticide regulations, seed certification and regulation, study of storage pests, pest warning systems, and research priorities on problems of major importance to food crops.

To attack the highest priority pest problems suggestions were made on how U. S. Universities might make an in-depth approach to specific pest problems. U. S. Universities might accomplish these objectives through scientists who could work and live overseas in "centers of excellence" such as international institutes or outstanding national universities. Funds would be provided for scientists to: 1) adequately survey the pest problem and local personnel working on the problem, 2) train local personnel, 3) break bottlenecks in research and extension, 4) sponsor annual workshops of regional workers plus world authorities, 5) provide adequate travel funds for the project coordinator, his assistants, cooperators in other countries, and periodic visits by consultants, 6) support local research of the project coordinator, 7) hold in-country short courses, 8) support of graduate students for overseas thesis research, 9) test solutions to the problems, as they arise, under farm and market conditions.

Since World War II many entities such as US-AID, U. S. Universities, private foundations, the UN-FAO, Japanese agencies, and numerous private agricultural chemical companies are engaged to some degree in plant protection activities in tropical East Asia. The International Rice Research Institute is doing excellent work on plant protection and it's organization, support, mode of operation, and interdisciplinary approach to pest problems can serve as a model to other international, foreign, and governmental agencies.

With the exception of vegetables, some fruits, and a few cash or plantation crops, pesticides are used only in modest amounts in tropical East Asian countries and environmental complications are probably not yet serious. However, with the intensification of agriculture, an increased use of pesticides, especially insecticides and herbicides, is predicted. In the countries visited (Japan excluded) environmental problems ensuing from the use of pesticides generally were of little concern in the face of overwhelming problems of health, hunger, and malnutrition. The use of DDT in public health is based on sound research, and will probably continue unless equally cheap and effective substitutes are found. In view of present worldwide opinion and scientific evidence concerning DDT in the environment, it seems wise to restrict its use to public health.

Serious problems exist in the storage, handling, distribution, packaging, application, formulation, and use of pesticides in crop protection in East Asia. Every effort should be made to improve this situation through short and long term training, bulletins, manuals, demonstrations and where necessary, legislation.

I. INTRODUCTION

Overpopulation is a major problem in tropical East Asia. Populations in most of the region will double in less than twenty years. Agriculturalists can do little to reduce the population explosion, but they can make significant contributions towards assuring an adequate food supply until populations become stabilized through family planning and birth control.

The objectives of the University of California/AID contract study team for tropical East Asia were to appraise the nature and scope of pest problems affecting food productions in individual countries and to determine whether the local environment and public health are endangered by improper use and lack of management of pesticides on food and other major crops. A set of priorities among the pest problems was to be determined and a role for the U. S. to assist in developing programs for their solution were to be suggested.

The study team was composed of Dr. E. H. Glass (Leader), Head, Department of Entomology, N.Y.S. Agricultural Experiment Station, Cornell University, Geneva, New York; Dr. H. David Thurston, Plant Pathologist, Department of Plant Pathology, Cornell University, Ithaca, New York; Dr. Ivan J. Thomason, Nematologist, Department of Nematology, University of California, Riverside, California; and Dr. Roy J. Smith, Jr., Weed Scientist, USDA, Stuttgart, Arkansas. All of these scientists had had overseas experience in their respective disciplines, and three of them had visited previously in East Asia.

The study team visited Philippines, Hong Kong, Thailand, Malaysia, Singapore, Taiwan and Japan. The latter country was studied only in terms of its overseas activities in crop protection and related problems.

II. Crop Protection Status in Southeast Asia

A. General

Agriculture in Southeast Asia varies from very primitive to highly sophisticated systems as advanced as those found anywhere in the world.

It varies from crops grown in small mountainside patches slashed and burned from the jungle to large, carefully managed plantations. In the former no modern inputs of any type are used whereas on the latter the latest and most sophisticated agricultural systems are carefully practiced. In between lies the major agricultural effort.

Just as with agriculture generally, crop protection practices vary from the most primitive to the most sophisticated involving the integration of all useful, available pest management practices. In most Southeast Asian countries included in this survey, however, crop protection practices with some exceptions are not adequate considering the magnitude of the problems. The reasons for this situation are many, but fundamental to their improvement is the expansion of research, extension and pesticide regulatory activities in all countries visited.

Intensification of agriculture in Southeast Asia has brought about certain changes and some new problems in crop protection. These can be termed "second generation" problems. Some of those identified by the team are as follows:

1. Pesticide resistant strains of insect pests have developed in the area. Two important examples are organophosphate resistant strains of the brown planthopper, *Nilaparvata lugens* on rice in the Laguna section of the Philippines and strains of the diamond back moth, *Plutella maculipennis*, on cole crops in all Southeast Asian sections to the chlorinated hydrocarbons, several carbamates and most organophosphates.

2. Pesticide residue problems have become very troublesome for crops requiring heavy pesticide applications close to harvest such as leafy vegetables. Meat contamination problems and residues in mushrooms and tobacco for export have been identified. Persistent herbicide residues are serious problems in rotations of short term crops or in intercropping

systems. Persistent soil insecticide residues are suspected to be causing crop damage in sugar cane in Taiwan.

3. Changes in the importance of pests on traditional crops has occurred in recent years with changing crop management practices. Perhaps the most outstanding example has taken place on rice following the introduction of the new high yielding varieties and the new technology associated with them. The brown planthoppers have become a severe pest on IR8 and have caused severe losses in some areas where adequate protective measures have not been taken. The leafhoppers have become more numerous in high yielding, densely-planted paddys and have increased the incidence of tungro and other virus diseases to epidemic proportion. On the other hand, the stem borers have been less damaging than formerly. Rice sheath blight has become more troublesome whereas rice blast has subsided in recent years consistent with the adoption of new varieties and technology probably because of the changed microenvironment with the new short varieties which are planted more densely.

Another example is the epidemic outbreak of the diamond back moth on cruciferous crops following the introduction and use of DDT and other persistent organic insecticides. This pest has become a limiting factor in the production of cole crops throughout East Asia.

Attempts to increase production of several crops is seriously hampered or prevented by a number of pests. A few examples follow:

Corn - downy mildew

- Heliothis spp., corn borers, others
- Weeds (Rottboellia sp. and Sciapus sp. following use of herbicides)

Sorghum - downy mildew, charcoal rot, rust

- shoot fly Atherigona soccata

Solanaceous vegetables and tobacco

- Heliothis spp., cutworms
- Bacterial wilt - Psuedomonas solanaceerum
- Root knot nematodes

Vegetables - Many insects, disease-causing organisms, nematodes and weeds

Some general observations on the status of crop protection that apply to insect, disease, nematode, weed and other pest management problems are as follows:

1. Losses due to pest damage have not been adequately identified by surveys or other means. Although there are exceptions as in the case of a few rice pests, generally there is little or no data available to support requests for crop protection research, extension and other much needed activities. Some crops needed for nutritional reasons are not grown because of attack by one or more pests. For example, several vegetables are not grown in the warm lowland areas because of attack by insects and disease. Bacterial wilt caused by Pseudomonas solanacerarum limits production of many solanaceous crops in much of Southeast Asia. This information is not adequately documented.

2. Economic threshholds have not been established for large numbers of pests in the area. For example, there is inadequate data on the levels of insect, disease, nematode, and weed pests of such crops as corn and legumes that cause economically significant losses of yield and quality. Such data are required to establish the need for instituting pest control practices.

3. Applied research in the field on crop protection with the possible exception of rice and certain plantation crops, is non-existent or inadequate in most countries visited. Even rudamentary trials with available pesticides are not being conducted on a number of important crops. As a

result, rather indescriminate use of pesticides is made in the vacuum of information on the what, when and where of pest control practices.

4. Extension activities and capabilities are inadequate in the countries visited with the exception of Taiwan (Japan not considered). Lack of information on sound crop protection practices, lack of training and training materials in practical crop protection as well as lack of operational funds are identified as causal factors for this situation. Much valuable research data has not been translated and developed for practical farmer usage. The large number of small farmers requires a large number of extension personnel. In Malaysia there is one extension man for every 3,000 farmers compared to one man for every 500 hectares or about every 500 farmers in Taiwan.

5. Pesticide regulations are inadequate or out of date in all the countries visited (Japan not considered). As a result the markets are deluged with all types of old and new pesticides, some of which may not be adequately developed for commercial use in the area as regards efficacy, safety to crops and applicators, and crop residues. Adulteration of pesticides especially at the dealer level. is a serious problem in the countries visited according to both industry representatives and government officials. The situation appears to be particularly flagrant where dealers dispense small quantities from large packages into unmarked containers. All countries visited are in some stage of planning for new pesticide regulation legislation.

6. Pesticide residues on edible crops are not adequately monitored in any of the countries visited. Residues well over tolerances established in the United States were reported to be common, particularly on vegetables. Eighty percent of the vegetable samples taken in Bangkok were reported to have residues above U. S. established tolerances. Workers in Hong Kong reported excessive BHC and lindane residues in duck meat. Cases were reported of dried fish being treated with pesticides for control of flies.

Facilities and trained personnel for determining residues vary greatly throughout the area but are judged to be inadequate in all countries in terms of the needs. Thailand has just constructed an excellent laboratory for residue and environmental quality monitoring, but sufficient trained personnel are not yet available. The problem of monitoring and policing pesticide residues in Southeast Asian countries is extremely difficult because of the large number of small farmers and the rapid transit from harvest to consumption. Recently government officials and politicians have developed a greater concern for residues because of restrictions on exports to Germany and Japan of crops such as tobacco with DDT residues.

7. Post harvest losses caused by rats, insects and fungi are generally recognized but inadequately studied. Rats, insects and fungi are serious problems in stored grains. Improved facilities for handling and storing rice have or are being constructed. Seeds stored for more than one or two months in the hot, humid tropics must be kept at low moisture and/or temperature as well as be protected from pests. Unavailability of seed due to a lack of suitable storage facilities is currently limiting the development of certain crops.

In Thailand, it was reported that most vegetables are sold within 24 hours of harvest because of rots and lack of suitable handling and storage facilities. Because of this, city markets must be supplied from locally produced vegetables grown under costly or often unsatisfactory situations. Thus, vegetables remain in limited supply at relatively high prices.

The often quoted figure that 50% of the fruits and vegetables grown in the tropics are lost because of pests appears reasonably accurate for the areas visited.

8. Resource literature and/or access to libraries are not available to

most crop protection scientists working away from the universities. This condition plus lack of travel funds professionally isolate these people.

B. Insects

Except for rice and certain plantation crops in Southeast Asia, the nature and amount of research being conducted on protection of crops from insect damage is inadequate to cope with existing conditions, not to mention the new problems that are anticipated as a result of further intensification of agriculture. The major efforts in crop protection research in the countries visited are being directed towards rice insects yet even here new problems are arising faster than solutions can be found. The stem borers are reported to be less troublesome in Taiwan, Philippines and Thailand than three or four years ago but are still of concern and are causing economic losses in Malaysia and in the second rice crop in the other countries. Planthoppers and leafhoppers have become a major threat to the high yielding varieties. Leafhopper populations in the Philippines have been extremely high in 1971 and have spread tungro virus disease to an estimated 10 to 15% of the rice crop. Intensive efforts are underway to develop rice varieties resistant to the planthoppers, leafhoppers and viruses. The tungro and hopper-resistant varieties, IR20 and C4-63G, have been introduced. Promising resistant varieties have also been introduced in Thailand and Taiwan.

On other crops most pest species have been identified, but the amount of information available on the biology of the pest species is inadequate. Basic data on distribution, seasonal development and abundance, host plant range, population dynamics, parasites, predators, and microbial agents are needed to develop sound control and management procedures.

Many chemical control practices on crops other than rice and plantation crops are based on foreign use practices and farmer experience.

Research on rates, timing, numbers of applications, intervals between treatments, residue disappearance curves, harvest residues, affects on parasites, predators and other crop pests has not and is not being done on a scale adequate to provide extension with sound and safe pesticide use recommendations.

Varying amounts of good work are being done on biological and microbial control of crop pests in most of the countries visited but more would be desirable. The potential for pest population explosions in the tropics is so great that every effort is needed to utilize selective control agents and practices that will not destroy the natural control systems.

The number of trained entomologists actively engaged in applied research in the countries visited was inadequate. There are a number of trained people in each country, but much of their time is devoted to teaching and/or administrative duties. There are not enough trained entomologists working as extension specialists in crop protection.

Support for crop protection research and extension by university and government administrations is not adequate, except possibly in Taiwan. This is evident from the failure to supply crop protection entomologists with supporting personnel, equipment and operational funds.

C. Plant Pathogens

In the tropical countries of East Asia visited, most of the diseases and their causal organisms, especially those of rice and cash and plantation crops have been identified. Thus, the descriptive phase of the development of plant pathology is near completion. With almost no exceptions, however, there is a serious lack of information on the economic losses caused by plant pathogens. Estimates made by scientists of losses vary widely, and obviously most are at best intelligent guesses. Most estimates of losses in the tropics indicate that they may be close to double those of temperate zones. However, the lack of serious, well planned studies of the losses caused by plant diseases in tropical areas means that administrations and politicians are not convinced of their importance, and support for research in plant pathology is therefore inconsistent and often ill-advised.

When one considers the huge numbers of farmers in tropical countries and the magnitude of the plant pathological problems facing the few trained scientists in these countries, it is obvious that there is a serious lack of sufficient trained personnel in plant pathology. Taiwan is in a much better position in this regard than the Philippines, Thailand or Malaysia. Existing personnel are seldom used with the greatest efficiency in problem-solving roles except perhaps in Taiwan. Malaysia now has an administrative structure (MARDI) which should greatly improve their situation. Thailand and the Philippines, however, lack a high level administrative plan at the national level to avoid duplication of effort and facilities, clearly define research and extension priorities and objectives, and combine teaching, research and extension activities into a working partnership. This lack seriously hampers the efficiency of the few trained scientists available. Far too often plant pathologists spend most of their time in teaching and in an intensive study of the causal organism of a disease and seldom extend this to studying the disease itself (the interaction of the host, the parasite and the environment). In more blunt terms, laboratory and greenhouse studies are no substitite for practical, applied research studies in the field. This observation is not intended as a critism of individual scientists. The existing situation is due to administrative deficiencies, the type of training most scientists receive today in the U. S. and Europe, and the fact that very few of the plant pathologists in tropical LDC's have ever had farm experience as most come from a stratem of society in which they do not actually till the soil with their hands.

Many scientists in Taiwan are doing an exceptional job with very limited equipment, but in all of the countries visited there were some deficiencies or needs for equipment and often these needs were blocking further progress in research. Library facilities in every country visited were inadequate to non-existent. This is a serious problem which must be solved. Financial support for supplies, trained assistants, operational funds, salaries, etc. were generally poor to extremely bad. After a country and/or international organization invests several years and $40-50,000 to train a Ph.D. it is completely illogical to give him a yearly budget of a few hundred dollars and a salary which encourages him to leave government service at the first opportunity. Fortunately, there are exceptions to the above, but relatively few were found in the countries visited.

Extension in plant pathology should be developed in the countries visited with the exception of Taiwan, which can serve as a useful model for extension activities to other tropical countries. Plant pathology extension specialists are needed to train extension agents and to work out practical control practices with researchers. With one exception (in the Philippines) such specialists were not found.

Research emphasis in all of the countries visited, with few exceptions, is too concentrated on controlling disease either by the development of resistant varieties or by chemical means. This is not to disparage the great importance of these two means of pest control, but research is lacking in other methods of disease control such as cultural methods, rotations, quarantines, biological control, manipulation of host nutrition, planting dates, etc.

In breeding for disease resistance, with few exceptions, little if any consideration is given to utilizing quantitatively inherited resistance rather than qualitatively inherited resistance. The use of singly inherited or monogenic resistance (qualitative inheritance) that can be overcome by the appearance of new physiologic races should be avoided (with a few exceptions such as certain root pathogens, viral and bacterial pathogens), where sources of quantitatively inherited resistance (partial, field, horizontal, multigenic, etc. resistance) are available which do not break down with the appearance of new races.

A last comment on the status of plant pathology in tropical East Asia is that there is not enough emphasis on crops other than rice. Many major food crops receive little if any attention and in some cases a minimum of effort might produce immediate practical benefits. Examples of important crops which receive little if any attention are pulses, starchy root and tuber crops, cooking bananas, and vegetables.

D. Weeds

The green revolution in Southeast Asia has intensified problems with weeds as well as other pests. The new, short, early-maturing fertilizer responsive rice varieties compete less effectively with weeds than later-maturing, less fertilizer responsive, taller varieties. Light which penetrates the canopy in plantings of the new varieties, stimulates growth of weeds and increases weed competition. Nitrogen and other fertilizer applied during the early growing season enhances weed growth to increase yield losses. The time for transplanting younger rice seedlings from seedbeds to the field and the practice of direct-seeding rice intensifies problems with weeds because competition begins earlier in the life of the rice plants.

Changing patterns in crop production, which include use of crop rotation and multiple cropping systems, intensify weed and herbicide residue problems in the rice and other crops in the system.

Changing patterns of crop management and protection will require more intensive research efforts on the part of the weed scientist. Effective herbicide management systems will have to be integrated with judicious management of insect, disease, and nematode control programs; water, fertilizer, varieties, seeding, and other productive practices.

Hand weeding and cultivation are the principal methods of weed control in Southeast Asia whereas herbicides are being used extensively in plantation crops with high cash value. The rice acreage treated with herbicides varies from country to country, but is usually estimated to be less than 10% of the crop. Upland food, feed and forage crops are seldom treated with herbicides. Plantation crops such as sugarcane, pineapple, rubber and oil palms are frequently treated with herbicides; these crops, however, enjoy the attention of government and private sectors because they are exported. As more emphasis is placed on food and feed crops and as more industry develops, weed control programs in these crops will become more important. Because the cost of labor for hand weeding has recently increased in Taiwan, the use of herbicides have increased. The amount of rice treated with herbicides in Taiwan increased from practically none in 1965 to 60,000 hectares in 1971, or about 5% of the total crop.

Although surveys of weed species in rice and plantation crops have been made in countries visited, information is lacking on weed species in newly introduced upland food and feed crops, rice or soybeans, corn, grain sorghum and vegetables; in forage and pasture crops; and in irrigation and drainage systems. Surveys of weed species causing major problems in these crops and areas should be encouraged.

Experiments on rice by the International Rice Research Institute (IRRI) and the University of Philippines College of Agriculture (UPCA) in the

Philippines and in plantation crops by other research organizations have shown that weeds reduce yields and quality of crops. For example, experiments at IRRI indicated that weeds must be controlled during the first 20 days after transplanting to obtain maximum growth of rice. Nitrogen timing and rates, variety, and crop and weed density also obviously affected the competition of weeds with rice. Similar information should be obtained on rice in Thailand, Malaysia, Taiwan and other countries, and in upland food and feed crops including corn, soybeans, grain sorghum, and vegetables in all countries visited. The effects of weed competition in pasture, forage, and vegetable crops are not known in any of the countries visited. Information from weed competition studies conducted in temperate areas often is not applicable to the topics because of differences in the growth of weeds and crops. Development of information on economic threshholds of weed populations should be emphasized.

Many experiments on the evaluation of new herbicides for use were observed in the countries visited. Frequently, weed control evaluations were based on groups of weeds such as grass, broadleaf, sedge or aquatic weeds rather than on individual weed species. Short term training for technical people working in weed control could improve herbicide testing programs.

Although experiments on the evaluation of herbicides for rice were frequently observed, herbicide testing programs were inadequate in soybeans, corn, grain sorghum, forage, pasture and vegetable crops. For example, Eupatorium sp., which is a troublesome weed in pasture crops in the Philippines, has not been researched at all. Development of projects for the control of weeds in pastures and forage crops should improve production. Aquatic weeds, which are abundant in tropical climates, have drawn little, if any, attention from weed scientists. Research on the biology of important weed species and in the evaluation of control methods including cultural, mechanical, chemical, and biological practices should improve weed control programs.

Ecological shifts of weed species were noted where herbicides had been used continuously for several years. A few examples of ecological shifts are: (1) The use of atrazine in corn or grain sorghum controlled susceptible weed grasses and other weeds in the Philippines, but after a few years Rottboellia exallata became the dominant weed because it was not controlled by the herbicide treatment. (2) Scirpus maritimus has become a troublesome weed in rice in the Philippines after several rice crops were treated with herbicides to control susceptible weeds, such as barnyard grass and monochoria. (3) Scirpus juncoides has developed significantly in plots where herbicides were used to control susceptible weeds. Because herbicides are not used widely in tropical Southeast Asia such ecological shifts occur infrequently. Research, however, to study the shifts of weed species with continual use of herbicides should pinpoint problems before they occur widely. Research to develop methods of preventing significant ecological shifts would be beneficial. Perhaps the practice of rotating both the crops and herbicides would prevent undesirable shifts of weed species.

Although some research is conducted on residues of insecticides and fungicides, residues of herbicides in soils, crops, and water are not adequately researched. In Thailand and Taiwan several well-equipped laboratories are available for residue analysis, but these facilities are not being used to determine herbicide residues. Initiation of research on herbicide residues in soil, crops, and water would establish base-line residue data before massive use of herbicides. Such information would be valuable for comparisons in the future as the use of herbicides increases.

Adverse interaction of herbicides with other pesticides has been observed by weed scientists. Propanil and carbaryl interact to adversely affect rice in experiments in the Philippines. However, research is inadequate on the interactions of herbicides with other pesticides. As the use of herbicides increases in Southeast Asia such research would identify problems before they occur in commercial fields.

In several of the countries visited scientists reported that endemic disease causing organisms and insects had killed specific weeds. However, research is not being conducted on the use of biological agents for controlling weeds. Surveys to identify specific endemic organisms that affect specific weeds may reveal effective biological agents for weed control. Research to develop biological weed control agents may be especially important for the control of aquatic weeds in irrigation systems.

Equipment for applying liquid formulations of herbicides usually consisted of small knapsack sprayers. However, farmers frequently are unable to buy these small sprayers because of the high cost. Consequently industry has developed granular formulations of herbicides that can be applied by hand when equipment for applying granular herbicides are not available. Research to develop inexpensive and effective equipment for application of liquid and granular herbicides is inadequate.

Weeds affected other pest problems in the countries visited. Many weeds are alternative hosts for diseases and insects. Leersia oryzoides is an alternate host for bacterial leaf blight of rice. Many weed grasses such as Echinochloa sp., Panicum miliaceum, and Zizania aquatica are host plants for rice stem borers. Weeds on levees and in waste areas give protective cover for rats and increase problems with these pests. Control of host plants and weed infestations in border areas may reduce problems with many pests.

In all countries visited weed research and extension personnel, with few exceptions, were inadequately trained in weed research. Many scientists were working only parttime in weed science, and frequently they were trained in plant breeding, plant pathology, plant nematology, or in other disciplines. A few weed scientists, who had been trained in the United States or in Europe, did not have an adequate understanding of weed problems in the field. In addition the limited weed source personnal available were frequently devoting most of their time to teaching rather than to research. Frequently applied weed research approaches which are desperately needed in Southeast Asia were being neglected. Many researchers were conducting weed control projects in the greenhouse rather than in the field where in tropical Southeast Asia the climate is suitable for conducting field research all year long if irrigation water is available during the dry season.

Frequently weed scientists located at field research and improvement stations away from university campuses did not have access to weed science literature and reference materials. Therefore, they could not develop effective weed research objectives and programs. Duplication of research efforts could become a problem as weed research is increased in Southeast Asia.

Nematodes

In the countries visited plant parasitic nematodes as causal agents of plant diseases have recently gained recognition from plant protection research workers and administrators. This view is supported by the recent addition of trained nematologists to government laboratories and university staffs in all countries visited and continued interest in training scientists in the field of nematology both in local universities and overseas. However, the present number of nematologists is seriously inadequate in comparison to the enormity of the problems. Furthermore, most well-trained nematologists are associated with major academic institutions or government laboratories in urban areas. Branch research stations have almost no trained nematologists or persons with B.S. or M.S. level training working on nematode problems.

At the present time it may be advantageous to have the best trained nematologists at academic institutions since there is a great need to provide instruction on nematode diseases and their control to all plant protection students and agronomists to increase their appreciation and understanding of these disease agents. It is also necessary to provide advanced training for students interested in this specialized field. However, nematologists at academic institutions tend to focus on laboratory-oriented research rather than field problems.

Preliminary surveys of nematodes associated with major crops have been conducted in all countries visited. These surveys have demonstrated the widespread occurrence of known plant pathogenic nematodes on important food and fiber crops. They have not assessed in most cases, however, the level of crop damage occurring, nor provided reasonable estimates of crop losses. Work is needed on the major food crops to provide additional information on economic threshhold levels and reliable estimates of yield losses attributable to nematodes or nematode-root rot complexes. This would provide a basis for additional administrative support for nematology.

Nematodes are particularly important on upland crops. Root-knot nematodes, Meloidogyne spp., are widespread in all countries visited and are associated with injury to vegetable, fruit, and fiber crops. Economically profitable yield increases following application of soil fumigant nematocides have been demonstrated, but nematocides are used at the present time only in the large scale plantation culture of such crops as pineapple, bananas, and rarely on sugarcane. Even in the culture of tobacco and tomatoes, which could easily benefit from seedbed soil treatment, little chemical control of nematodes occurs.

Two nematode diseases of rice occur in Southeast Asia. These are White Tip caused by Aphelenchoides besseyi and Rice Root Rot or "Mintek" caused by Hirschmaniella spp. There is evidence that White Tip may be becoming more important with changes in rice varieties and the reduction in the use of organophosphate insecticides for stem borer control in Taiwan. This disease is receiving additional attention in Taiwan. The nematodes responsible for Rice Root Rot are widely distributed in paddy soils in Southeast Asia and yield increases of 10% have been obtained following nematode control in seedbed and paddy with nematicides. No commercial use of nematicides in rice culture has resulted, but the research suggests future research on varietal tolerance or resistance and/or control through crop rotation. Second crop rice yields are always lower and one factor contributing to reduced yields may be higher Hirschmaniella populations.

Rotation of vegetable crops with paddy culture of rice which is practical in Taiwan and limited areas of other Southeast Asian countries, has minimized the severity of many nematode problems on these crops since flooding reduces the population of root knot and other important nematode species. This observation suggests the importance of additional research on population dynamics of plant parasitic nematodes in other crop rotation systems in Southeast Asia.

It was noted in many countries that nematode resistance available in certain crop varieties or rootstocks was not being utilized either directly or in breeding programs. In countries where sophisticated fumigation technology is not available greater emphasis should be placed on the use of resistance and cultural control methodology.

The burrowing nematode, Radopholus similis, a serious pathogen of bananas, has been reported from the Philippines and Thailand and is widespread in Malaysia. It has not been found, however, in Taiwan. Since the presence of important nematode pathogens of roots can result in embargoes on the shipment of certain root crops to foreign markets, it is extremely important to prevent the introduction or continued distribution of specific injurious nematodes. Thus all country quarantine agencies should have trained nematologists to assist in the preparation of quarantine regulations and develop detection procedures.

There is a serious lack of information available for the extension worker and the farmer. Every effort should be made to translate suitable research results into information useful for regulatory officials, extension workers, and farmers.

Professionals working in nematology and others concerned with nematode diseases now tend to be isolated from each another. Every effort should be made to help them meet periodically, as do for example the members of the Organization of Tropical American Nematologists (OTAN), to exchange results, techniques and ideas. Within country short courses should be held frequently to upgrade the training and performance of research officers, extension specialists and technicians at outlying stations.

National collections (museums) of plant parasitic nematodes were found to be seriously inadequate in most countries visited. Collections of permanent slides of nematodes and mass collections are important for identification and instructional purposes. One laboratory in each country should be designated as the national repository for permanent material and adequate facilities provided for its protection and preservation.

Finally, since trained nematologists are in minimal supply in all countries visited, every effort should be made by administrators to clearly define nematological research priorities and to see that significant problems of importance to the agricultural economy are attacked at this time.

F. Pesticides

Government regulations in all the countries visited permit private enterprise to introduce and market pesticides. The only general requirement is registration of a product. No restrictions were observed except in Taiwan and Hong Kong where the sale of highly toxic pesticides are prohibited. New, modern and more restrictive legislation is being considered in the Philippines, Thailand, Malaysia and Taiwan.

As a result of the above policies, most pesticides useful in Southeast Asia are available, but distribution to the right place at the right time is a difficult problem. Also, certain products, such as certain nematicides, currently have such a small market that industry does not find it profitable to supply them. Industry introduces new pesticides for some markets before they have been fully developed and approved for use in countries with restrictive legislation such as the United States.

The principal markets for pesticides in Southeast Asia are vegetables, fruits, and plantation crops. Most vegetables and many fruits cannot now be grown without chemical protection. The demand and prices for these foods are good so the cost/benefit ratio for pesticide use is very favorable. Plantation crops are generally well managed using practices established by research and experience, and pesticides are used as required. Use of herbicides is increasing rapidly on plantations, particularly where labor is not readily available or is expensive. On the other hand, the pesticide market for rice, corn, root crops, forage crops, etc., is still small and expected to grow very slowly because the cost/benefit ratios are unfavorable or unpredictable.

At present the use of pesticides is relatively small in all countries visited except Taiwan. For example, the 1971 sales in the Philippines was 30,000,000 pesos or about US $4,000,000, with 17 million peso for insecticides, 8 million for herbicides, 4 million for fungicides, and 1 million for rodenticides and miscellaneous. The general consensus of the industry representatives interviewed was that the pesticide market in Southeast Asia is and will continue to grow more rapidly than in the developed countries, perhaps 20% per year, but the total market will be relatively small for many years.

Adulteration of pesticides was reported to be a problem in all countries visited. Misbranding also occurs. Part of the problem results from the practice of dispensing small amounts to the farmers from large packages. DuPont is trying small, foil sealed packaging in amounts suitable for the commonly used knapsack sprayers.

Residues and environmental contamination have not been adequately studied in the area. Where pesticide residues on food crops have been determined, evidence indicates that vegetables commonly reach the market with residues above those established by the United States Food and Drug Administration (80% of vegetable samples in Thailand, 5% in Taiwan). Chlorinated hydrocarbons can no longer be used on tobacco to be shipped to Germany and Japan because of residues. Fish kills in rice paddies treated with endosulfan and endrin have been reported in several countries.

Industry attempts to support research on pesticides by making grants to universities and research stations. The effort has not been very successful generally because of the limited capacity of these institutions to conduct such research. Japan's pesticide industry has formed the Japan Agricultural Chemical Overseas Development Commission which supports research and extension in Southeast Asia and has sponsored several symposia for crop protectionists from the area countries.

G. Pest Quarantine

In the countries visited the team found a general awareness and recognition of the importance of maintaining adequate quarantine practices to prevent the introduction of new pest species into the area. There is an organization of East Asian quarantine specialists who attend regional meetings to discuss and develop procedures to deal with such problems. This project has support from the UN-FAO. The team did not have the opportunity to evaluate the effectiveness of the quarantine practices in any of the countries visited.

III. Crop Protection Needs in Southeast Asia

Certain essential components to a successful crop protection program are lacking to some degree in all the countries visited in Southeast Asia. Among the basic needs identified by the team were increased administrative and financial support for survey, research and extension programs in crop protection. For example, in the Philippines the effectiveness of the Bureau of Plant Industry is seriously hampered because the agency is fragmented into too many small substations which too often are staffed by inadequately trained personnel trying to operate without adequate funds, equipment and reference literature. In this same country, extension is also fragmented and administratively separate from companion agencies, a situation that hampers coordination of research and extension and the flow of information to the farmer. In Thailand the crop protection research activities are divided among several agencies, each of which has its own group of satelite substations. Instances were observed where several physically contiguous substations were working on similar or related problems without coordination of effort. In Malaysia an excellent program is underway to collect and coordinate all agricultural research into one cohesive agency, the Malaysian Agricultural Research and Development Institute (MARDI). Significant results in crop protection are already evident even though MARDI has only assembled part of its staff. Research and extension in Taiwan are well organized, although some simplification and improved coordination between agencies would be helpful.

Reference literature was lacking at most research stations. This very serious deficiency, observed for all crop protection disciplines, isolates workers from developments in their field. Some system such as that used by EAFRO in East Africa (Appendix III) is needed.

The support provided for crop protection research and extension services throughout Southeast Asia was found to be variable but was generally quite inadequate in terms of the work that must be done in the near future. There is definitely a great need for operational money for supplies, labor, technicians, equipment and transportation. The funds that are now being spent for salaries and property maintenance in some places, particularly at isolated substations, is a poor investment because the personnel are often unproductive due to lack of training, support and guidance. Such a situation is particularly serious because it fosters loss of morale by the scientist and cynicism among farmers and the public about the role of agricultural research and extension.

Another great need in Southeast Asia is an improved salary structure for crop protection scientists actively engaged in research and extension. Present salaries force these people to seek outside income through consulting work, a second job, business enterprises, etc., all of which dissipate the scientists time and energy. Because advancement is slow, progressive and productive workers are being forced to seek relief in administrative positions or in private enterprise where beginning salaries are usually 3 to 4 or more times those in government and university service.

There is a need to reevaluate and perhaps reorient existing crop protection research and extension activities. The team identified some research projects on minor problems or minor crops which absorb time and resources which could better be devoted to more important activities. Likewise, as stated elsewhere, too much emphasis is being devoted to laboratory aspects of pest organisms with too little attention to the pests in the field and control on the farm. To aid administrators and directors of crop protection activities, it is essential that crop losses due to pests be surveyed, and that priorities be established for future research. For example, grain and seed storage losses due to several pests and post-harvest rots of vegetables account for tremendous losses or serious limitation to even short-term conservation or distribution of seeds and foods yet there is very little research activity underway on these problems.

Crop pests are frequently limiting factors in new agricultural enterprises. Consideration of crop protection problems in planning new developments is often neglected until a crisis develops. There is a need to consider crop protection in planning agricultural developments such as irrigation projects, multiple cropping, and introduction of new crops. Experience indicates that it is simply impractical to grow some crops in Southeast Asia because of the devastating damage inflicted by one or more pest species. For the same reason, more emphasis should be made to develop crops that are more suited to the area and have no limiting pest problems.

Pesticides are being used for crop protection in limited quantities in Southeast Asia except on fruits, vegetables and plantation crops. More extensive use is made of pesticides on rice in Taiwan than in other countries visited. Increased usage of pesticides is expected over the next ten years. Even with present use levels, however, several problems of misuse, adulteration, misbranding, accidents and residues have developed. There is need to initiate or update pesticide regulations, monitoring and policing of pesticide sales and use in Southeast Asia.

The study team for East Asia has given major consideration during its discussions, interviews and field trips to the task of identifying the insects, diseases, weeds, nematodes and other pests that are or may become major pests in Southeast Asia. The team also tried to identify pest problems which prevent of the plants, let alone the production of an edible crop. The high value of such vegetables on the market assures a profitable cost/benefit ratio for pesticide use. In Hong Kong, it was reported that the return for vegetables was 9 to 10 times that for rice, so the trend has been to import rice and grow vegetables locally in spite of the need for high pesticide usage.

These considerations further emphasize the need for improved pest management based on the crops involved and the local conditions. They also lend further weight to the need for improved crop protection systems for vegetables, fruits and other nutritionally needed foods, foods which are now generally in short supply and expensive by local standards.

The team regularly asked the many people interviewed about local problems of environmental contamination, hazards to human health and life, harmful effects on domestic animals or wild life resulting from the use of pesticides. To summarize briefly, there was found to be very little concern for such matters, particularly for the environment.

As stated elsewhere, residues on export commodities are of great concern whenever they restrict the available market. More concern is developing for pesticide residues in foods, and efforts are being made to monitor and control these in several countries. Studies of environmental contamination appear to be almost non-existent in the areas visited and to have very low priority.

In the opinion of the team, the amounts of pesticides being used in all countries visited, with the exception of Taiwan, do not yet constitute any serious environment al contamination problem or threat to wildlife. There are localized exceptions, however, such as in concentrated vegetable areas. There is also the threat to wildlife from the use of rodenticide 1080 through secondary and even tertiary poisoning. Fortunately the use of this material seems to be decreasing.

There is also the threat to fish and other aquatic life from the use of certain pesticides in rice paddies. Contamination of drinking water for man and animals is also a potential danger. Studies made so far, however, indicate no problems from the use of recommended materials.

Actually the threat to wildlife by man himself is probably greater than from his crop protection practices. The ever increasing population that continues to encroach on the remaining wildlife areas, the harvesting of timber, expansion of mining operations, agriculture, etc., all have effects greater than those from pesticide usage.

On the other hand, the predicted increased usage of pesticides will pose greater and greater problems for the Southeast Asian countries in the future. This team would urge that efforts be made to limit the use of pesticides and develop sound crop protection systems through integrated approaches to the problems before the pesticide problem does become acute.

As stated elsewhere, the team found no evidence that DDT as used for malaria control or other public health uses constitutes a significant hazard. It is applied by trained personnel using soundly-based procedures.

V. Possible Approaches to Solutions of Crop Protection Problems

The increased yields of the green revolution are based on the widespread use of a small core of germ plasm, larger plant populations per hectare, increased use of fertilizer, increased pressure to obtain two to three crops per year from the same land, more widespread use of irrigation, and improved cultural methods. It is paradoxical and unfortunate that often these practices increase the chances of serious attacks by pests and pathogens. The current tungro virus epidemic on rice in the Philippines is an excellent example. Numerous deficiencies have been identified by the team during their study tour of tropical East Asia. The following suggestions are made in an effort to point out possible approaches to solutions of crop protection problems. It is hoped that these suggestions will be useful to agencies working in international agriculture.

One of the most glaring deficiencies in all tropical countries visited was the lack of adequate library facilities. A solution to this problem which has been found to be cheap and practical by EAFRO in East Africa is the following. By using the best area library facilities available a list of all available journals pertinent to crop protection can be sent to any interested scientist in any tropical East Asian country. The scientist can check those journals in which he is interested (perhaps a dozen for example in Plant Pathology). Thereafter, he would be sent a Xerox copy of the title page of each journal in which he is interested every month as journals are received in the library. The scientist would then request articles by checking only those which interest him, and he would be sent Xerox copies of those articles free or for a minimal fee. In this way one complete library can service an entire region at minimal cost. Local libraries would only have to have the most essential books and reference material and scientists, no matter how isolated, could keep up with all future literature. Several libraries already provide services for obtaining reprints of any article previously published, and excellent literature bibliographies are available on many important tropical crops. A description of a successful service of this kind used by the East African Agriculture and Forestry Research Organization is included in the appendix.

Numerous books and references can be found on the cash and plantation crops of the tropics such as sugarcane, rubber, coffee, tea, cocoa, citrus fruits, and bananas for fruit, but, except perhaps for rice, there is a paucity of information on food crops as they grow in the tropics. Nevertheless, much valuable information has been accumulated on these crops during the last decade or two. This information could easily be consolidated in a usable form at minimal cost if the most highly qualified scientists available in East Asia were subsidized to write such books and texts. In addition to their value to other researchers, extension workers, administrators, commercial interests, etc., such books would be of great value in teaching. At present the majority of the texts used in teaching plant protection in tropical LDC's are written by authors from temperate zones about pests of the temperate zone. Although the principles and methods in crop protection may be the same the crops and application of principles is not.

Pesticide regulation is still in its infancy in all tropical East Asian countries visited. Few countries seem to be even mildly concerned at present about the mounting contamination of the environment by agricultural chemicals because of the overwhelming problems of producing food for their rapidly expanding populations. Services prerequisite to pesticide regulation, i.e. residue laboratories, residue surveys, research on residues, training of scientists trained in pesticide determinations, etc. need support because within a short time, such matters may become of vital concern to East Asian tropical countries. A modest investment at this time in support of such activities may produce large dividends in a few years. FAO is now actively engaged in supporting pesticide residue studies.

Much more emphasis needs to be placed on seed certification and regulation, especially as it influences the control and spread of diseases and weeds. Sponsored studies and subsequent action programs on this subject could have rapid benefits to tropical LDC's.

It is recognized that pests of stored food products (rats, insects, fungi, etc.) cause serious losses in all tropical LDC's. Fruits and vegetables are seldom stored for any appreciable length of time because of post-harvest deterioration. Few national or international agencies in tropical East Asia have serious studies or projects on storage problems and/or solutions to these problems. The study team believes that significant contributions could be made by initiating sound research, extension, and action programs in this area after thorough study by qualified scientists.

Japan and Taiwan have excellent pest warning systems for reducing the impact of pest epidemics or epiphytotics, especially on rice. Similar programs for rice and eventually other crops should be considered for other countries, since with minimal expenditures, immediate savings to farmers for pesticides could be made without serious crop loss once an adequate system is programmed.

A vacuum in research in plant protection on certain important tropical crops exists in tropical East Asia. These crops are grain legumes, forages and grasses, starchy root and tuber crops, and cooking bananas. For example, although cassava is universally grown for food, starch, and in some countries as an export crop to Europe to feed animals not one researcher was found in all of tropical East Asia working on pests of cassava. These crops should be given higher priorities for future research by national and international agencies.

One of the main objectives of the study team was to determine a set of priorities among the pest problems encountered and suggest possible solutions. Pest problem priorities are listed in Tables 1-5. Examples of such priority regional projects are control of the root knot nematode (<u>Meloidogine</u> species) on tropical crops, (over 50 tropical crops seriously attacked around the world), control of bacterial wilt (<u>Pseudomones solanacearum</u>) of tropical crops (attacks many plant species of economic importance in the tropics), control of rice viruses, control of downy mildew of corn (nine species of <u>Sclerospora</u> attack corn in the tropics), control of <u>Plutella</u> sp. attacking crucifers in the tropics, control of <u>Heliothis</u> sp. (which attacks a wide range of crop plants in the tropics), and control of purple nutsedge (<u>Cypetus rotundus</u>) on upland crops (this may be the most important weed, economically, in the tropics, especially in upland crops). These are but a few of the more important examples (<u>not</u> in any order of priority) which would be amenable to attack by the following project structure with assurance of meaningful accomplishments in a reasonable length of time.

If we take one of the above projects as an example, it might develop in the following manner:

A U. S. University group of Universities with competence, interest, and experience with the type of pest problems to be attacked would be responsible for the execution of the project.

It would be the responsibility of the University to select the best possible scientist(s) to coordinate and be responsible for the entire program. He or they would be or become a member(s) in full standing of the staff of that University. He would be stationed overseas in tropical East Asia preferably at a center of excellence such as IRRI in the Philippines, the Vegetable Production Center, the Rice Protection Center or Kasetsart University in Thailand, the U. P. College of Agriculture in the Phillipines, or MARDI in Malaysia. It would be hoped that he could be given staff privileges, housing, laboratory and greenhouse facilities, etc. at one of these institutions. His location would be determined by the specific pest problem and a consideration of all other pertinent factors. The scientist would achieve his objectives as follows:

1. He would have adequate travel funds to thoroughly survey the problem and all the people and countries working on the problem in East Asia. It would be his responsibility to identify the best scientists and centers of excellence to cooperate on the project on an interdisciplinary basis.
2. He would have funds to select and train the best possible local personnel needed to devise solutions to the problems both on a short and a long-term basis.
3. He would have funds to break bottlenecks in research and extension. In other words, through his study of indigenous projects he would be able to supply funds for such items as laboratory and field equipment and supplies, greenhouses, books, etc., which are holding back the progress of the outstanding workers on the problem.
4. He would have funds to sponsor annual workshops of regional workers plus selected world authorities. It would be expected that such workshops would serve to stimulate cooperation, exchange of materials and information, instruct in depth area workers on the latest worldwide advances on the problem, provide documentation in the form of papers, technical articles and reports, and aid in evaluating the potential of area scientists to contribute to the solution of the problem.
5. Travel funds would be available for the project coordinator, his assistants, and cooperators in other countries (if justified) for

regional travel.

6. Funds would be available for outstanding graduate students (both from the U. S. A. and cooperating tropical countries) to do graduate research thesis projects pertinent to the overall aims of the project in tropical East Asia.
7. Funds would be available to provide for regular, periodic visits by the best available consultants (U. S. or foreign) to aid in the coordination in the progress and evaluation of the project. Such visits could usually coincide with the workshops.
8. Funds would be available to support the local research of the project coordinator. It is strongly believed that if the coordinator is to receive the respect and cooperation of his cooperators he must be actively engaged in an important aspect of the research on the problems so he can maintain a working colleague relationship with his cooperators and not simply the relationship of an advisor. Depending on his location and the institute, agency, foundation or university where he establishes his base of operations, funds might be needed for labs, greenhouses, vehicles, labor, technical assistants, secretarial help, housing, etc.
9. Funds would also be available to hold in-country short courses (not regional) as results are obtained to extend results of the research to other scientists, extension workers, etc.

The aforementioned suggestions are prompted in large measure by the great need to take the orientation in plant protection research away from the concentration on organisms as objects of scientific curiosity in the laboratory and towards the solution of practical problems as they exist in farmers' fields.

VI. Some International and Foreign Agencies Engaged in Plant Protection Activities in Tropical East Asia

Before World War II, most of the activities in the East Asian tropics in plant protection were undertaken by the Dutch, English, French and Americans, primarily on cash and plantation crops. Since World War II, other entities such as US-AID, U. S. Universities, private foundations, the UN-FAO, Japanese agencies, and numerous private agricultural chemical companies from many countries are engaged in some degree in plant protection activities in tropical East Asia.

An outstanding example of an international agency doing successful research in the Asian tropics is the International Rice Research Institute supported by the Ford Foundation, Rockefeller Foundation, U. S. AID and other agencies. It has made and continues to make outstanding contributions to plant protection in rice with a very small professional staff, but with superlative administrative support and leadership, excellent laboratory, greenhouse and field facilities, generous technical help, and adequate budgets. This mode of operation, including long-term personnel, to assure continuity in research programs, emphasis on a single crop in great depth, and an interdisciplinary approach to pest problems should serve as a model for other pest protection activities by international and foreign agencies.

It would be difficult to list all of the US-AID projects and U. S. University projects (which are usually supported by US-AID) in East Asia, but several of these have had an important impact on pest protection in tropical East Asia.

The US-AID Rodent Research Center in Los Banos, Philippines is an excellent example of a promising project. Their excellent and extensive data on losses caused by rats in the Philippines impressed us as an excellent base from which to build their program. The Ford Foundation, in addition to its support of IRRI, has supported the University of the Philippines College of Agriculture - Cornell University Graduate Education Program at Los Banos, plus a multiple cropping program in northern Thailand.

The Rockefeller Foundation, in addition to its activities with IRRI, maintains a staff in Thailand among which plant pathologists and entomologists are included. Much of their program is directed towards disease control, especially in rice, corn and sorghum.

The Food and Agricultural Organization (FAO) of the United Nations have several projects in tropical East Asia. A plant pathologist is working on the cadang-cadang disease of coconuts in the Philippines, and crop protection institutes are being established in Korea, Taiwan, Thailand, and Indonesia. Four plant protectionists are working in Thailand, and at present one each in the other East Asian countries. These projects have the potential to be important centers in the future.

The Japanese government works in plant protection in tropical East Asia through three agencies: 1) The Overseas Technical Cooperation Agency which gives technical assistance through the Colombo plan; 2) the Tropical Agricultural Research Center which is part of the Ministry of Agriculture, Forestry and Fisheries; and 3) JACODEC (Japan Agricultural Chemicals Overseas Development Commission) a semi-official organization to encourage use of Japanese agro-chemicals overseas. A wide range of activities including training, research and extension activies are conducted overseas by these agencies.

Few of the innumerable agro-chemical commercial companies of Europe and North America who sell pesticides in tropical East Asia actively engage in research activities. Such activities are usually carried out in cooperation with national governmental agencies. Cyanamid Far East Ltd. is establishing a Foundation in the Philippines where pest protection research can be conducted.

The Asian Development Bank has no direct involvement of plant protection activities, but does support plant protection if it is needed in relation to development loans for agriculturally related projects.

VII. Pesticides in Public Health Activities

The use of pesticides in public health was not the primary purpose of the teams visit to tropical East Asia, but time was taken to investigate this controversial question. DDT is still the number one pesticide used in public health programs and, although many other materials have been tested by AID malarial control programs, the UN/WHO programs, and national governments, no satisfactory substitute for DDT has been found. The next best compound is five times as expensive as DDT and may not be as effective. Many LDC governments are taking over the entire cost of anti-malarial programs, and they do not feel they could bear this additional cost.

No evidence of a single death or impairment of health through the use of DDT for anti-malarial programs was discovered in the countries visited. As DDT is used in and on dwellings for control of malaria, there is a minimum of contamination of the environment. These considerations, plus the statement of the Surgeon-General of the U. S. A. that DDT is not a carcenogenic or tumor-producing compound leads to the conclusion that DDT will and should be continued to be used in anti-malarial programs until an equally cheap and effective compound is found. No evidence was found in the countries visited that resistance to DDT was present in the mosquito vectors of malaria.

APPENDIX I

East Asian Pest Management Study Team Itinerary

October 16 - 18, 1971: Honolulu, Hawaii: Reef Hotel. Final organization of team, review of assignment, review of agricultural Statistics for Philippines, Thailand, Malaysia and Taiwan. Review of proposed itinerary in Philippines.

October 18 - 20: In transit, Hawaii - Japan - Philippines

October 20, 2:35 PM: Arrived Manila airport, met by Mr. Hipolito Custodio, Chief, Pest & Disease Control Section, BPI, and Mr. Jose Morales, Chief, Pest & Disease Control Division, BPI. Transferred to Bayview Hotel, Manila. Spent the rest of the afternoon discussing the purpose of our visit and the itinerary of the team with Mr. Custodio and Mr. Morales.

October 21:

8:30 AM - 9:30 AM: US-AID headquarters, Manila. Team met with Mr. Donald Yeaman, Agric. Mission Director. Discussed US-AID Agricultural Program in Philippines and US-AID Pesticide Purchase Program in Philippines.

9:45 AM - 10:15 AM: U. S. Embassy, Manila. Discussed Philippine purchase of U. S. Agricultural commodities with Mr. Frank L. Waddle, U. S. Agricultural Attache.

10:30 AM - 12 Noon: Asian Development Bank, Manila. Discussed with Dr. S. C. Hsieh, Director of Projects, and staff (Mr. Chih Chen, Agronomist, Dr. S. T. Senerviraine, Senior Agronomist, and Mr. Alex S. Burnstan, Operations Officer) the function and operation of the ADB as it relates to Agriculture development projects and particularly their concern for pest protection activities in development projects. ADB supporting Vegetable Research Center in Taiwan.

2 PM - 4 PM: Headquarters, Bureau of Plant Industry, Manila. Meeting with Dr. Eliseo Carandang, Director, BPI, Mr. Jose Morales, Chief, Pest & Disease Control Division, and Mr. Hipolito Custodio, Chief, Pest & Disease Control Section and staff (15 staff in attendance - list of names available). Problems relating to quarantine; seed introduction, storage and testing; rice, vegetable, and citrus production and pest control discussed.

October 22:

8 AM - 10 AM: Travel Manila to University of Philippines, Los Banos with Hipolito Custodio.

10 AM - 12 Noon: College of Agriculture, UP, Los Banos. Meeting with Dean F. T. Orillo; Dr. Marcus R. Vega, Director of Research; Dr. E. B. Oyer, University of Philippines - Cornell University Program, and the following program leaders or representatives: P. J. Alfonso, Ent. & Zoology; F. C. Quebral, Plant Pathology; Edward B. Pantastico, Botany; T. Contado, Director Ext. Education; A. A. Gomez, Director of Instruction; and F. F. Sanchez, Director, Rodent Research Center. Discussed Plant Protection research in UPCA and the Rodent Research Center, and the staff interest in US-AID sponsored research. Instructional and extension education activities were also discussed.

12 Noon - 2 PM: Lunch with Dean F. T. Orillo, Directors and Department Heads, UPCA.

2 PM - 5 PM: Visits and discussions with staff members in the Department of Entomology & Zoology, Plant Pathology and Botany, UPCA.

I. J. Thomason discussion of Instruction and Research in Plant Nematology with Dr. Ceasar Madamba, Department of Entomology & Zoology, Dr. Romulo G. Davide, Dr. Rodrigo B. Valdez, Dr. Manolo B. Castillo, Mr. Tiburcio

Reyes of the Department of Plant Pathology, Dr. E. H. Glass, Entomology Staff, H. David Thurston, Plant Pathology, Dr. Flor Quebral, Dr. P. A. Benigno, Dr. P. M. Hales, Dr. D. B. Lapis, and Dr. Roy Smith, Botany with Drs. Marcos Vega and B. L. Mercado.

October 23:

8 AM - 9:30 AM: IRRI Rice Seminar, Smith, Thomason and Thurston. Glass, discussions with Dr. Gabriel, Entomologist and later with Drs. Oyer and Feuer.

10 AM - 11:30 AM: Discussion of Plant Pathological Research with special emphasis on downy mildew (*Sclerospora* spp.) of corn with Dr. O. R. Exconde, Chief, Department of Plant Pathology, Dr. Elmer Johnson, CIMMYT, H. D. Thurston, I. J. Thomason, and Dr. Roy Smith with researchers in Botany Department.

12 Noon - 2 PM: I. J. Thomason and E. H. Glass, guests of Dr. Ceasar Madamba at Los Banos Rotary Club. Topic: Revised Crop Protection Loan Policy of Rural Banks by former UPCA Dean Santos.

2 PM - 4 PM: Team visited site of new Cyanamid Research Foundation Experimental Farm and discussed plans with Dr. F. Calora.

8 PM - 11 PM: Glass, Smith, Thomason and Thurston. Discussion with Dr. Ed Oyer, Director, UPCO Project.

October 24:

12 Noon - 1:30 PM: Discussion with Dr. F. B. Calora, Entomology, American Cyanamid Corp.

1:30 PM - 6 PM: Tour of Agricultural areas between Los Banos and San Pablo

6 PM - 7 PM: Glass, Smith, Thomason and Thurston, discussion with Dr. S. H. Ou, IRRI plant pathologist.

7:30 PM - 10 PM: D. Thurston and I. Thomason, discussion with Dr. O. R. Exconde, Chief, Department of Plant Pathology, UPCA; Glass and Smith, discussion with F. F. Sanchez, RRC, Los Banos.

October 25:

9 AM - 9:30 AM: International Rice Research Institute (IRRI), Los Banos, Dr. McClung, Director. Discussion of IRRI activities in Southeast Asia.

9:30 AM - 10 AM: Dr. A. S. Athwal, Asst. Director for Training. Discussion of training programs of IRRI.

12 Noon - 1 PM: Discussion with IRRI Staff

1 PM - 2:30 PM: Review of rice insect research program by Drs. M. D. Pathak and V. A. Dyck.

2:30 PM - 3 PM: Review of herbicide research by Paul Berniassoa

3 PM - 4:30 PM: Review of rice breeding by Drs. H. M. Beachell, G. S. Khush

4:30 PM - 5:15 PM: Review of multiple cropping research program of IRRI by Dr. G. Banta, economist

October 26:

9 AM - 10 AM: Review of Rodent Research Center (RRC) program and facilities by Dr. F. F. Sanchez, Director.

10 AM - 11 AM: Glass and Thomason, accompanied by H. Custodio, travel to Cabuyao, Laguna

11 AM - 12 Noon: Observations of RAM Corporation, vegetable and fruit growing and packing operation.

1 PM - 3 PM: Visit BPI Lipa Experiment Station, Lipa City, to review programs with Condo rado I. Gonzales (Superintendent), Aureo L. Martinez, Senior Plant Pathologist and Ciriaco Celino, Senior Entomologist.

3 PM - 5 PM: Travel from Lipa City to Manila

10 AM - 5 PM: Smith & Thurston; trip 84 kilometers north of Manila with G. V. Bautista, Agric. Production Commission and I. C. Bolo, IRRI Technical Coordinator to observe tungro disease of rice and weed control experiments.

7 PM - 10 PM: Union Carbide Corporation - Dinner Discussion. J. B. So and other company representatives.

October 27:

9 AM - 10 AM: Meeting with Mr. Domingo F. Panganiban, Deputy Executive Director of National Food & Agriculture Coordinating Council (NFAC) at Diliman, Quezon City. Discussed NFAC's function in stimulating and coordinating agricultural production and research in the Philippines.

11 AM - 3 PM: Manila. Meeting with Mr. Renato Cupinpin, President, Agricultural Pesticide Institute of the Philippines, and the Executive Committee of the institute. Fourteen persons were in attendance including 8 executive committee members, Mr. Jose L. Morales (BPI), Mr. Hipolito Custodio (BPI), and the study team. Problems and prospects for pesticide use in the Philippines were discussed (a list of participants is available).

3:30 PM - 4 PM: Contacted Dr. Horst Geuting, United Nations Development Program (UNDP), Manila. Meeting postponed until 6 PM because of local labor strike.

6 PM - 7 PM: Discussed UNDP interest and programs in Plant Protection with Dr. Geuting.

7 PM - 10 PM: Dinner discussion with Dr. Dennis S. Fox, Stauffer Chemical Co., and Dr. Feliciano Calora, American Cyanamid Corp.

October 28:

8:30 AM - 12 Noon: US-AID office, Manila. Discussion of Philippine Agric. & Crop Protection problems with Dr. Frank W. Sheppard, Manager, and Mr. Allen C. Hankins, Deputy Food & Agric. Officer, Office of Rural Development, US-AID.

1 PM - 2:30 PM: Dr. Glass discussed Mango Pest & Production problems with Mr. S. Yuson, largest philippine Mango grower.

5 PM: Departed Manila by air to Hong Kong.

October 29:

9:30 AM - 10:30 AM: U. S. Agricultural Attache, Mr. Steve Washenko, U. S. Embassy, Hong Kong.

11:30 AM - 1 PM: Dow Chemical Co., Hong Kong - Roy Smith and I. J. Thomason discussed Plant Protection problems and pesticide use in Southeast Asia with Mr. R. H. Ferguson, Manager, Research & Development, Mr. T. A. Kolomyjec, Entomologist, and Mr. William R. Fronk, Senior Analyst.

10 AM - 12 Noon: Hong Kong Dept. of Agriculture & Fisheries - D. Thurston and E. Glass discussed crop protection problems with Dr. Robin Mason, Agriculturist and Miss Vera So, Plant Pathologist.

1 PM - 5 PM: Monsanto Far East, Ltd., Hong Kong - H. D. Thurston and E. Glass discussed plant protection problems and pesticide usage with Drs. John Taylor, Donald Banks, and Richard Isherwood. They further discussed the plans for an agricultural research foundation to be established in the Philippines with American Cyanamid foundation funds.

October 30:

12 Noon - 2 PM: Dr. E. Glass met with Dr. Douglas Tate, Far East Consultant, Uniroyal Corp., to discuss pesticide use problems in Southeast Asia.

4:30 PM - 6:30 PM: Travel Hong Kong to Bangkok, Thailand.

October 31:

9 AM - 11:30 AM: Bangkok. Meeting of survey team (Glass, Smith, Thurston & Thomason) with Dr. Ray Smith, FAO Consultant and Manager, University of California, US-AID Pest Management Project to discuss survey progress.

11:30 AM - 5 PM: Meeting Dr. Bap Reddy, Plant Protection Expert, FAO Regional Office, Bangkok, with survey team and Ray Smith to review FAO plant protection activities in Southeast Asia.

November 1:

8:30 AM - 5 PM: Kasetsart University, Bangkok. SEADAG Rural Develop Panel Seminar on "Research Needs on Crop Protection Systems".

November 2:

7 AM - 7 PM: Field trip to Nakorn Pathom and Kanchana Buri Field Station with Dr. Sothorn Prasertpol and Mr. Swang Wangboonkong, Entomologists, Ministry of Agriculture, Bangkok. Those attending were Ray Smith and Joe Tanada, Entomologists, University of California, Berkeley; Ed Glass, Roy Smith and I. J. Thomason. Many crops observed but primary emphasis was on insect problems of cotton and their control.

8:30 AM - 8:55 AM: H. D. Thurston, visits and field trips. Rice Protection Research Center, Department of Rice, Ministry of Agric.

9 AM - 9:25 AM: Dept. of Ent., & Plant Pathology, Kasetsart University.

9:30 AM - 9:55 AM: Plant Protection Research Center, Dept. of Agric., Ministry of Agric.

10 AM - 1 PM: Travel to Farm Suwan

1 PM - 5 PM: Visit National Corn & Sorghum Research Center, Farm Suwan, Nakorn Ratchsima Province, and private fruit farms.

November 3:

8:30 AM - 5 PM: Kasetsart University, Bangkok. SEADAG Seminar.

6:30 PM - 9:30 PM: I. J. Thomason. Project discussion with Dr. Carl Knorr, FAO Project Leader, Bangkok.

November 4:

8 AM - 9 AM: O/AG and O/HPP Staff at USOM. Discussed plant protections and pesticide procurement with Dr. Fowler, Deputy to Dr. Fletcher Riggs, and Mr. Timmons. Reviewed public health problems with Mr. Murphy.

9:30 AM - 10:30 AM: Dr. Georg Schutz, FAO, UNDP Bldg. Discussed efforts of FAO to coordinate crop production research and avoid duplications of effort.

11 AM - 12 Noon: Mr. Vibul Sthitirat, Chief of Division, Foreign Agriculture Relations, Ministry of Agriculture, and staff. Rajadamnern Avenue, Bangkok. Discussion of markets for Thai Agric. Products.

2 PM - 3 PM: Dr. Bhakdi Lusananda, Director General, Rice department and 15 staff members. Discussed rice protection problems in Thailand including diseases, insects, nematodes, rats and birds.

3 PM - 4:30 PM: H. D. Thurston rice disease discussion with Dr. Piya Giatgong and Plant Pathology staff. I. J. Thomason meeting with Miss Dara Buangsuwon, Chief, Nematology section and staff. E. H. Glass meeting with Dr. Kovit Kovitvatee, Head, Entomology Department; Roy Smith - discussed rice weed research with Dr. Srasurang Watana and staff.

6:30 PM - 9:30 PM: H. D. Thurston and I. J. Thomason. Discussion with Dr. James Jensen and Dr. Bobby Renfro, Rockefeller Foundation, and approximately 20 Thai Plant Pathologists about starting Thailand Society of Plant Pathology.

November 5:

8 AM: I. J. Thomason to Northeast Agric. Research Center, Khon Kaen by air. Met by Dr. William Brown, Plant Pathologist, University of Kentucky - US-AID team.

11 AM - 5 PM: Visited experimental plantings in Khon Kaen area with Dr. Brown, Dr. (Miss) Doungjai Chupunya and Mr. Chalermwong Tirawat, Entomologist.

6 PM - 10 PM: Reviewed Northeast Thailand Agric. Development with Dr. Brown.

9 AM - 11:30 AM: Thurston, Glass and Smith. Mr. Thumnong. Singalavanija, Director General, Dept. of Agric. Extension, MDA. Plant Pest & Disease

Central Center, MOA.

11:30 AM - 12 Noon: Meeting Dr. Carl Knorr, FAO.

1:30 PM - 2 PM: Dr. Dwight C. Finfrock, Ford Foundation, 8th Floor, Thai Farmers Bank Bldg., 142 Silom Road. (Roy Smith discussed rice weed research and multiple cropping experiments with Finfrock till 5 PM).

2:30 PM - 3 PM: H. D. Thurston & E. H. Glass with Dr. C. P. Pant, Project Leader and staff, WHO Aedes Research Unit, Dept. of Medical Sciences, Ministry of Public Health, Devaves Palace.

3:30 PM - 5 PM: H. D. Thurston & E. H. Glass with Dr. Vimol Notananda, Deputy Director (and staff). National Malaria Eradication Project, Ministry of Public Health.

November 6:

7 AM - 5 PM: E. H. Glass and H. D. Thurston visited Corn and Forage Improvement Center, Farm Suwan in company with Drs. Bobby Renfro, Plant Pathologist, Charles L. Moore, Plant Breeder, Dale G. Smeltzer, Plant Breeder, and Ray Smith, Entomologist, University of California, Berkeley.

8 AM - 2 PM: Roy Smith reviewed Rice Weed Research at Kasetsart Univ. with Mr. Prachern Kanchanornai and staff.

2 PM - 5 PM: R. Smith discussed international rice weed control experiments with Dr. K. Hayashi, Regional Rice Improvement, International Rice Officer, FAO, Bangkok.

8 AM - 12 Noon: I. J. Thomas observed research facilities for agriculture in the vicinity of Khon Kaen and attended a seminar on crop protection in Northeast Thailand at Northeast Agric. Research Center. Returned to Bangkok in PM.

November 7:

7 AM - 11 AM: Study of vegetable and fruit marketing in Bangkok accompanied

by Plant Pathologists Dr. Bobby Renfro, Mr. Udom Pupipat, Dr. Riksh Syamananda, Miss Anong Chansrikul, Miss Leka Satanimi and Dr. Ear. Hansen (University of Wisconsin).

7 PM - 10 PM: H. D. Thurston and I. J. Thomason discussion of plant pathology problems in Thailand with Dr. Riksh Syamananda, Mr. Udom Pupipat, Miss Anong Chansrikul, Miss Leka Setanimi and Dr. Earl Hansen. E. H. Glass and R. Smith discussed pest and pesticide problems with Dr. I. R. Belshaw, Union Carbide.

November 8:

8:30 AM - 9:30 AM: Glass, Smith, Thomason and Thurston meeting with Drs. James H. Jensen, Ben Jackson, Bobby Renfro, Rockefeller Foundation, Kasetklang Bldg., Kasetsart University.

9:30 AM - 11 AM: Meeting with college administrators and Plant Protection leaders, College of Agric., Kasetsart Univ., Asst. Vice-Rector Dr. Phaitoon, Dean Pavin Punsti, Dr. Thira Sutubutr, Dr. Aroon Chantanao, Dr. Sutharm Areekul, and Mr. Umpand.

11 AM - 1 PM: Meeting with Dr. Albert L. Taylor and Dr. Carl Knorr, FAO, Plant Protection Bldg., Kasetsart University.

2 PM - 3 PM: I. J. Thomason, H. D. Thurston, and R. Smith. Meeting with Dr. Hynal, USOM and Prof. Charas Yamarat, Dean, Faculty of Public Health, Mahidol University, 420/1 Rajvithi Road. Discussion of pesticide problems related to public health. Glass-Rice Protection Center with Dr. Kovit.

7 PM - 9 PM: R. Smith discussed pest and pesticide problems in rice with Dr. K. Hayashi.

November 9:

9 AM - 11 AM: Glass, Smith, and Thurston meeting with Dr. Phaderm Titatarn, Deputy Director, Dept. of Agric., Bangkaen; Dr. Riksh Syamananda,

Director, Plant Industry Division, Dept. of Agric., Bangkaen, and staff, on plant protection research in Thailand.

2 PM - 4 PM: Review meeting with Dr. Fowler and Mr. Timmons, USOM headquarters.

6 PM - 8:30 PM: By air to Kuala Lampur.

November 10:

8 AM - 9 AM: Kuala Lampur, Malaysia. Team meeting with Mr. Dale K. Vinning, U. S. Embassy Agric. Attache.

9:30 AM - 10 AM: Team meeting with Dr. Enche Anuwar, Director, MARDI, MARDI Headquarters.

10 AM - 10:45 AM: Team meeting with Dr. A. H. Moseman, Assoc, Director, MARDI.

11 AM - 11:30 AM: R. Smith and H. D. Thurston meeting with Dr. A. K. Seth and Mr. R. S. Elias, Imperial Chem. Industry, Agriculture (Malaysia). I. J. Thomason & E. H. Glass meeting with Mr. Richard D. Locke, Du Pont Far East, Inc.

11:30 AM - 1 PM: Smith and Thurston meeting with Dr. Wen-Poh Ting, Chief, Plant Protection Division, MARDI, and staff (11 people). Plant Protection Program Review.

11:30 AM - 12:30 PM: Glass and Thomason, visit to Pertanian Agricultural College. Thomason discussed Nematology with Mr. Khoo Khey Chong. Glass reviewed entomology program with Dr. Djamin.

1 PM - 2 PM: Team discussion of Malaysian Agriculture with Dr. Ting and Dr. Ho.

2:30 PM - 4:30 PM: Team meeting with Mr. B. Sripathi Rao, Mr. E. Push-parajah, Dr. Wastie, Mr. Y. K. Woo, and Dr. Lim Tow Ming of Malaysian Rubber Research Institute to discuss their plant protection programs.

6 PM - 9 PM: Team discussion of Plant Protection Problems with Dr. Ting.

November 11:

7 AM - 7 PM: Glass & Thomason taken by car by Mr. Thian-Hua Ho, Entomologist, Pest Control Research Branch, MARDI, to the MARDI Station, Cameron Highlands, and to visit vegetable farms (accompanied by Mr. Tan Sui, Agriculturist to Kea Farm and Briachang Farm).

8 AM - 3 PM: Smith & Thurston by air accompanied by Dr. Ting to MARDI Rice Research Station, Bumbong Lima. Discussed rice research program with Mr. Xavier Nathan, Director, and his staff.

4 PM - 5:30 PM: Smith & Thurston visit with Dr. Lim Wah Ching, University of Penang.

November 12:

8:30 AM - 10:30 AM: Thomason to Faculty of Agriculture, Univ. of Malaya. Visited with Dr. Varghese, Plant Pathologist, and Dr. Winoto, Nematologist, accompanied by Mr. Yuen Pak Mun, Nematologist at MARDI.

10:30 AM - 12 Noon: Thomason visit with Dr. Siew, Dr. Lee, and Dr. Bullock, School of Biological Sciences, University of Malaya. Discussed integrated control programs for pests.

8:30 AM - 10 AM: Glass & Smith visit with Mr. Ahmad Yunus, Director, Crop Protection, and Dr. K. G. Singh, Quarantine Officer, Division of Agriculture. Dr. Balasurbramanian, Toxicologist, reviewed pesticide residue research.

10 AM - 12 Noon: Glass & Smith reviewed the problems of crop protection with Dr. Ting and Mr. Ho, Crop Protection Research Division, MARDI.

12:30 - 4:15 PM: Kuala Lampur to Singapore by air.

November 13:

10 AM - 1 PM: Singapore. Discuss Pesticide Marketing and problems in Southeast Asia with Mr. Ferdinand Micklautz, Area Supervisor, and Mr. Rolf Jesinger, Agriculturists, Far East Chemical Services, Inc. (Rhom & Haas Co.), Dr. Arthur B. Brelsford, Marketing Manager, Far East Agric. Chemicals, FMC, and Dr. Charles Adair, Plant Pathologist, Dept. of Biology, Nanyang University, Singapore.

6 PM - 10 PM: Conversations with Mr. F. Micklautz, Rohm & Haas Co., on Southeast Asian pesticide marketing problems.

November 14:

10 AM - 6 PM: Singapore to Taipei, Taiwan by air.

8 PM - 10 PM: Taiwan Agric. problems discussed with Mr. Stassen Y. C. Soong, Far East Regional Manager, Stauffer Chemical Co., Dr. W. R. Furtick, Project Manager, FAO Plant Protection Center, and dr. Ren-Joung Chiu, Head, Plant Protection Division, JCRR and Mr. T. T. Lo, Plant Pathologist, JCRR.

November 15:

8:30 AM - 10 AM: Team visit with Dr. Luh and PID staff (7). JCRR, Taipei.

10:30 AM - 12 Noon: Team visit to Taiwan Agric. Research Institute (TARI). Dr. Wan, Director, Dr. Sally Chiu, Head, Entomology Section; Dr. C. L. Chu, and Dr. C. H. Wang, Plant Pathologist.

1:45 PM - 2:30 PM: Visit with Mr. T. P. Wang, Deputy Director, Bureau of Commodity Inspection & Quarantine. Reviewed program and viewed testing and quality control laboratories.

3 PM - 4 PM: Thomason visit to Pesticide Residue Lab, Mr. Horng and Mr. Sie.

4 PM - 5:30 PM: Thomason visit with Dr. C. S. Huang, Nematoligist, Academia Sinica. Glass - visit Dr. David F. Yen and staff, Entomology

Dept., National Taiwan University. Thurston - visit with Dr. Paul Sun, Plant Pathologist, JCRR. Smith - visit with Mr. C. C. Wang, Agronomist, National Taiwan University.

7 PM - 9 PM: Dinner JCRR Reception Room, Host, Dr. T. H. Shen, Chairman, JCRR (12 guests).

November 16:

8 AM - 9 AM: Team plus Dr. Furtick & Dr. Paul Sun to Kaohsiung by air.

9:30 AM - 12 Noon: Visit to TARI Horticulture Station, Fengshan, Mr. C. H. Yu, Director, Mr. C. h. Lin, Agriculturist, and staff.

12 Noon - 1:30 PM: Lunch discussion of Kaohsiung District agriculture. Team, Furtick, Sun, Director Lin and Mr. Y. D. Hung, Director, Kaohsiung Dist. Agric. Improvement Station, Pingtung.

1:30 PM - 3 PM: Dist. Agric. Improvement Station, Director Y. P. Hung and staff.

4 PM - 5 PM: Taiwan Sugar Expt. Station, Taiwan. Mr. Stone, Shi Ping Chi, Agr. Specialist and staff (C. H. Liang, Ent., S. H. Peng, Agron.).

7 PM - 9 PM: Taiwan crop protection discussion: T. D. Wang, Chief, Plant Protection Section, Dept. of Agric. & Forestry, Taiwan; Mr. T. K. Sun, Senior specialist, Sec. of Plant Protection, Dept. of Agric. & Forestry; Dr. Furtick, Dr. W. Brown and team.

November 17:

8:30 AM - 9:45 AM: Team visit to TARI Fiber Crop Station, Taiwan. Discussion & observation of plots, Mr. C. C. Tu, Acting Director, and Head, Dept. of Plant Protection and staff.

10 AM - 12 Noon: Team visit to District Agric. Improvement (DAIS), Taiwan. Discussion of Disease & Pest Forecasting System in Taiwan.

1 PM - 2 PM: Team visit to TARI, Rice Improvement Station, Chiayi. Mr. C. H. Tao, Head and Entomologist, and staff. Mr. W. L. Chang, Weed

specialist.

2 PM - 4 PM: By train from Chiayi to Taichung.

4:15 PM - 5:30 PM: Team visit to Shing Nunig Chemical Co., largest agricultural chemical industry in Taiwan.

November 18:

9 AM - 11 AM: Glass, Thomason & Thurston visit to Depts. of Entomology and Plant Pathology, National Chung Hsing Univ., Taichung. Dr. Ku-Shing Kung, Dean, College of Agric., Dr. S. K. Sun, Head, Dr. H. T. Hsu, and Dr. M. S. Kuo, Plant Pathologists, Dr. Shu-Cheu Chang, Entomologist & Head, Dept. of Entomology, and staffs.

9 AM - 11 AM: R. Smith visit to DARI, Taichung, to discuss weed control with Mr. Pao-Chin Lin, Senior Specialist, and staff.

11 AM - 12 Noon: R. Smith to Agronomy Dept., Chung Hsing Univ., to visit with Dr. Ying-Chuau Lu and staff. Glass, Thurston & Thomason, Provincial Dept. of Agric. & Forestry Ext. Center., Taichung.

2:30 PM - 5:15 PM: Team transportation Taichung to Taipei by train.

6 PM - 11 PM: Taiwan to Tokyo by plane. Met at airport by Dr. Taizo Maeda, Deputy Director, Development Division, Kumiai Chemical Industry Co.

November 19:

9 AM - 11 AM: Team visited Tropical Agriculture Research Center, Tokyo, accompanied by Dr. S. Matsumoto, Plant Pathologist, TARC. Reviewed program of TARC with Dr. Noboru Yamada, Director.

11:30 AM - 2 PM: Team visited staff in the departments of Entomology & Plant Pathology, National Institute of Agricultural Sciences, Ministry of Agriculture. Dr. T. Mizukami, Head, Dr. H. Fujii, Dr. T. Watanabe, Dr. H. Kato, Dr. R. Saki, Dept of Plant Pathology. Also Dr. M. Ichinohe, Nematologist and Drs. Jun Mitsuhashi, Socho Nasu, and To Yushima, Entomologists, and Dr. Kazano, Toxicologist.

2 PM - 4 PM: I. J. Thomason extended visit with Dr. Ichinohe.

3 PM - 6 PM: E. Glass and H. D. Thurston met with K. Yamashita and H. Hirata, Toyo Menka Kaisha, Ltd. R. Smith met with Dr. Taizo Maeda, and Ichiro Kimura, Kumiai Chem. Industry Co.

November 20:

10 AM - 2 PM: Tokyo. Team participated in a JACODEC (Japan Agricultural Chemicals Overseas Development Commission) Seminar organized by Mr. Toshio Sohma, Deputy Secretary General and presided over by Dr. Hidetsugu Ishikura, Director General, Japan Marine Science & Technology Center. Approximately 15 representatives of the Japanese Agricultural Chemical Industry as well as Dr. Matsumoto of TARC and Dr. Shoji Yoshimura of Agr., Forestry & Fisheries Council were present.

November 21 - 23: Tokyo. Team prepared Preliminary East Asia Study Report for submission to US-AID and Project Director.

November 22:

12 Noon - 2 PM: Team met with Mr. R. N. Hale, Regional Agricultural Products Manager, Far East Chemical Services, Inc. (Rohm & Haas Co.).

November 24: Team travel from Tokyo to U. S. A. by air.

APPENDIX II

Table 1. Food crop insect pests of major significance in Southeast Asia.

Pest Common Name	Scientific Name	Crops Affected	Countries Involved	Research Priority[a]	Promising Approaches
Green leafhopper[b]	Nephotettix apicalis	Rice	South & S. E. Asia, Japan	1	Resistant varieties, chemical
Green leafhopper[b]	Nephotettix impicticeps	Rice	Taiwan, Indian sub-continent, Japan		Resistant varieties, chemical
	Nephotettix cincticeps	Rice	Japan, Taiwan, Korea, Manchuria, China		Resistant varieties, chemical
Brown planthopper	Niloparvata lugens	Rice	All East Asia	2	Resistant varieties, chemical
Yellow stem borer	Tryporyza incertulas	Rice	All East Asia, China, Indian subcontinent	1	Biological control, resistant varieties
Striped rice borer	Chilo suppressalis	Rice, grassy weed	Asia, Egypt, Spain		Biological control, resistant varieties
Pink borer	Sesamia inferens	Rice, sugar-cane, maize, wheat, barley, and grasses	Asia		Biological control, resistant varieties
Gall midge	Pachydiplosis oryzoe	Rice, grassy weeds	India, S. E. Asia, (except Philippines, Taiwan), Africa, Ceylon	1	Systemic insecticides, cultural, resistant varieties
Diamond-back moth	Plutella maculipennis	Cruciferous crops	World-wide where these crops are grown	1	Biological, cultural, selective insecticides
	Heliothis spp.	Corn, sorghum, legumes, many more	World-wide in tropical to temperate climates	1	Resistance, biological, selective insecticides
Shoot fly	Atherigona soccata	Sorghum, corn	Pakistan, India, Thailand	1	Resistance, selective insecticides

Table 1 continued:

Armyworms & cutworms	*Prodenia* spp.	Legumes, corn, vegetables	World-wide	2	Cultural, microbial diseases
Stored grain insects	Several spp.	Rice, corn, sorghum, wheat, etc.	World-wide	1	Selective pesticides, storage conditions
Melon fly[c]	*Dacus curcurbita*	Curcurbit-aceae crops & weeds	All S. E. Asia	2	Poison baits, attractants
Oriental fruit fly[c]	*Dacus orientalis*	Many fruits	All S. E. Asia	2	Poison baits, attractants

a/ Research priority: 1 = highest, 2 = high, 3 = important but lower priority
b/ Major importance as a vector of rice viruses
c/ Exports to Japan and U.S.A. restricted by quarantine legislation against crops attacked by this pest.

the establishment of desirable food or other crops. The major pest problems for the area are listed in Tables 1 to 5 with ratings of their importance as judged by the criteria set forth in PROP for the AID-University of California, Berkeley, Project.

IV. Economic and Environmental Implications of Crop Protection Practices in Tropical East Asia

In countries where agricultural chemical industries are allowed to operate on a competitive basis the use of pesticides tends to seek economically profitable levels of use irrespective of official or private recommendations or propaganda. Just because the use of a pesticide will increase yield by 20% or even 50% is no assurance that its use is beneficial or practical for the farmer. This is particularly true on subsistance farming, low value crops or where there are high risks of crop failure from uncontrollable factors such as weather.

Rice is an example where considerable efforts have been made by both the private and government sectors to use insecticides to increase rice production. Experiments at Los Banos and Munoz in the Philippines have shown remarkable yield increases, particularly with the new high yielding varieties. These increases have been consistent during all seasons at Los Banos but mainly for the irrigated dry-season crop at Munoz. Increases in grower trials, however, have been quite variable and the general use of insecticides is not considered economically sound on a cost/benefit ratio basis by some economists and many farmers. The variable factors need to be known.

On the other hand, the team observed during this study trip and during previous overseas experience that pesticides are regularly and consistently used on certain crops irrespective of recommendations or location. Vegetables such as cabbage, potato, and tomato are examples where insecticides and fungicides are used regularly. In fact, they must be used to insure survival

Table 2. Food crop pathogens of major importance in Tropical East Asia.

Pest Common Name	Scientific Name	Crops Affected	Countries Involved	Research Priority[a]	Promising Approaches
Virus diseases of rice	a. Tungro b. Grassy stunt c. Orange leaf d. Yellow dwarf e. Transitory yellows	Rice	a. All E. Asian countries visited b. Ditto c. Ditto d. Ditto e. Taiwan	1	1. Breeding 2. Date of planting studies 3. Chemical control of vector 4. Rotation
Rice blast	Pyricularia oryxae	Rice	All countries visited	2	1. Breeding 2. Chemical control 3. Manipulation of nutrition
Bacterial blight of rice	Xanthomonas oryzae	Rice	All countries visited	1	1. Breeding
Bacterial streak of rice	Xanthomonas translucens	Rice	All countries visited	3	1. Breeding
Sheath blight of rice	Rhizoctonia sp.	Rice	All countries visited	1	1. Breeding 2. Rotation 3. Manipulation of nutrition
Brown spot of rice	Helminthosporum oryzae	Rice	All countries visited	3	1. Breeding 2. Chemical control
Downy mildew of corn	1. Sclerospora philippineusis 2. S. sorghi (still not proven) 3. S. maydis 4. S. sacchari	Corn Corn and Sorghum Corn Corn and sugarcane	Philippines, India Thailand Indonesia Taiwan	1	1. Breeding 2. Chemical control 3. Date of planting studies

Table 2 continued:

Corn leaf spots and rust	Numerous species	Corn	General distribution S. E. Asia	3	1. Breeding
Corn stalk rots	Numerous species	Corn	Ditto above	2	1. Breeding 2. Rotation
Corn root rots	Numerous species	Corn	Ditto above	2	1. Breeding 2. Rotation
Virus and myco-plasma diseases of sweet potato	a. Witches' broom b. Feathery mottle c. Internal cork d. Leaf spot e. Mosaic (TMV)	Sweet potato	Unknown - little information except in Taiwan	1	1. Breeding 2. Clean seed 3. Chemical vector control
Miscellaneous leaf spots (fungal) & root rots of sweet potato	Numerous species	Sweet potato	Because of little work on sweet potato distribution not well known	2	1. Breeding 2. Rotation 3. Chemical control
Diseases of cassava	Numerous species	Cassava	Although cassava is an important crop in E. Asia almost nothing is known of diseases present, their importance or distribution. Not <u>one</u> worker on cassava disease was found in E. Asia.	1	1. Breeding 2. Clean planting, stocks 3. Heat or chemical treatment of planting stocks
Bacterial wilt	<u>Pseudomonas solanacearum</u>	1. Tomatoes 2. Potatoes 3. Peanut 4. Ginger 5. Eggplant 6. Tobacco 7. Bananas & plantains 8. Pepper 9. Many weeds	General distribution in Tropical East Asia	1	1. Breeding 2. Rotations

Table 2 continued:

Storage rots of vegetables & fruits	Numerous species	Almost all vegetables	General in Tropical E. Asia - 50%	1	1. Breeding 2. Chemical control 3. Storage method studies 4. Packaging studies
Bananas & Plantains (Sigatoka) Cercospora leaf spot	*Mycosphaerella fijiinesis*	Banana & plantain	General distribution	4	1. Chemical control 2. Breeding
Coconut - Cadang-Cadang	Causal agent unknown	Coconut	Philippines	4	1. Vector control 2. Cultural methods of control 3. Breeding
Citrus - Viruses & mycoplasma diseases	a. Greening (mycoplasma) b. Tristeza (virus) c. Other	Citrus species	General distribution	2	1. Clean planting stocks 2. Breeding 3. Resistant root stocks 4. Chemical vector control
Pulses - Miscellaneous diseases	Numerous species	Pulses	General distribution, but this is not very well known	1	1. Breeding 2. Chemical control 3. Rotation 4. Dates of planting

a/ Research priority: 1 = highest, 2 = high, 3 = important but lower priority

Table 3. Weeds of food crops of major importance in Tropical East Asia.

Pest Common Name	Scientific Name	Crops Affected	Countries Involved	Research Priority[a/]	Promising Approaches
Nutsedge	*Cyperus rotundus*	Corn, sorghum, soybeans, sugarcane, vegetables	All E. Asian countries	1	Cultural, herbicides, mechanical
Barnyardgrass Jungle rice	*Echinochloa colonum*, *E. crus-galli*	Rice, sorghum, soybean, vegetables	All E. Asian countries	1	Cultural, mechanical, herbicides
Monochoria	*Monochoria vaginalis*	Rice	All countries	1	Cultural, mechanical, herbicides,rotation
Smallflower umbrellaplant	*Cyperus difformis*	Rice	All countries	1	Cultural, mechanical herbicides, rotation
Asian bulrush	*Scirpus maritimus*	Rice	Philippines	2	Rotation, herbicides, cultural
Fimbristylis	*Fimbristylis* sp.	Rice	All countries visited	3	Rotation, cultural, herbicides
Gooseweed	*Sphenoclea zeylanica*	Rice	Philippines	3	Rotation, cultural, herbicides
Itchgrass	*Rottboellia exaltata*	Sugarcane, soybeans, corn	Philippines	2	Herbicides, cultural, mechanical
Crabgrass	*Digitaria* sp.	Soybean, corn,sorghum, vegetables	All countries	2	Herbicides, cultural, mechanical
Morningglory	*Ipomoea* sp.	Corn, soybeans, vegetables, sorghum	All countries	2	Herbicides, cultural, mechanical

Table 3 continued:

Spikerush	*Eleocharis* sp.	Rice	All countries	2	Herbicides, cultural, mechanical, rotation
Sprangletop	*Leptochloa chinensis*	Rice	Thailand	3	Herbicides, rotation, cultural, mechanical
Paspalum	*Paspalum scrobiculatum*	Rice	Thailand	2	Herbicides, cultural, mechanical, rotation
Water primrose	*Jssiaea repens*, *J. binifolia*, *J. suffruticosa*	Rice	All countries	2	Herbicides, cultural, mechanical, rotation
Pepperwort	*Marsilea crenata*	Rice	Thailand, Taiwan	2	Herbicides, cultural, mechanical, rotation
	Ischaemum barbatum	Rice	Thailand	2	Herbicides, cultural, mechanical, rotation
	Pennisetum pediullatum	Corn, sorghum, soybeans, vegetables	Thailand	2	Herbicides, cultural, mechanical
Spurge	*Euphorbia* sp.	Corn, soybeans	Thailand	3	Herbicides, cultural, mechanical
Goosegrass	*Eleusine indica*	Corn, sorghum, soybeans, vegetables	All countries	2	Herbicides, cultural, mechanical
	Alteranthera sessiles	Rice	Taiwan	3	Herbicides, cultural, mechanical, rotation
False pimpernel	*Lindernia* sp.	Rice	Taiwan	3	Cultural, herbicides, rotations, mechanical

Table 4. Food crop nematode pathogens of major importance in Tropical Southeast Asia.

Pest Common Name	Scientific Name	Crops Affected	Countries Involved	Research Priority[a]	Promising Approaches
Root-knot nematodes	*Meloidogyne* spp.	Many vegs., bananas, fruit trees	All S. E. Asian countries visited	1	1. Chemical control 2. Crop rotation 3. Resistant varieties 4. Cultural methods
Reniform nematode	*Rotylenchulus reniformis*	Many vegs., pineapple, banana, fruit trees	Philippines, Thailand, Malaysia	1	1. Chemical control 2. Crop rotation 3. Resistant varieties
Burrowing nematode	*Radopholus similis*	Banana, citrus (?)	All S. E. Asian countries visited	1	1. Exclusion 2. Quarantine 3. Chemical control 4. Cultural control
Lesion nematodes	*Pratylenchus* spp.	Vegs., fruit trees (including citrus), banana and cassava	All S. E. Asian countries visited	2	1. Crop rotation 2. Resistant varieties 3. Chemical control 4. Cultural control 5. Exclusion
White tip nematode	*Aphelenchoides besseyi*	Rice	All S. E. Asian countries visited	3	1. Resistant varieties 2. Seed treatment
Rice root rot (Mantek)	*Hirschmaniella* spp.	Rice	Ditto above	3	1. Resistant varieties 2. Crop rotation 3. Chemical control
Spiral nematodes	*Helicofylenchus* spp.	Banana, vegs., fruit crops	Ditto above	2	1. Crop rotation 2. Cultural practices 3. Chemical control 4. Resistant varieties
Citrus nematode	*Tylenchulus semi-penetrans*	Citrus	All S. E. Asian countries visited	3	1. Resistant rootstocks 2. Chemical control 3. Cultural practices

Table 4 continued:

Mushroom nematodes	*Ditylenchus myceliophngus* & *Aphelenchus avenae*	Mushrooms	Taiwan	2	1. Cultural practices 2. Chemical control

a/ Research priority: 1 = highest, 2 = high, 3 = important but lower priority

Table 5. Miscellaneous important pests of food crops in Southeast Asia.

Pest Common Name	Scientific Name	Crops Affected	Countries Involved	Research Priority[a]	Promising Approaches
Rats	Several spp.	Rice, corn, sorghum, oil palm coconuts, stored products, etc.	All S. E. Asian countries visited	1	Selective poison baits, cultural
Birds	*Munia m. maja* *Ploceus philippinensus infortunatus*	Rice, sorghum	All S. E. Asian countries visited	3	-
Snails	-	Vegetables	All S. E. Asian countries visited	2	-
Slugs	-	Vegetables	All S. E. Asian countries visited	2	Baits
Crabs	-	Rice	Malaysia	3	-

a/ Research priority: 1 = highest, 2 = high, 3 = important but lower priority

Table 3 concluded:

Toothcap	*Rotala* sp.	Rice	Taiwan, Malaysia	2	Cultural, herbicides, rotation, mechanical
Lalang	*Imperata cylindrica*	Sugarcane, vegetables	Thailand, Malaysia	2	Cultural, rotations, herbicides, mechanical
Rice cutgrass	*Leersia oryzoides*	Rice	All countries	2	Rotation, herbicides, cultural, mechanical
Pigweed	*Amaranthus* sp.	Soybeans, corn, vegetables, sorghum	All countries	2	Herbicides, cultural, mechanical

a/ Research priority: 1 = highest, 2 = high, 3 = important but lower priority

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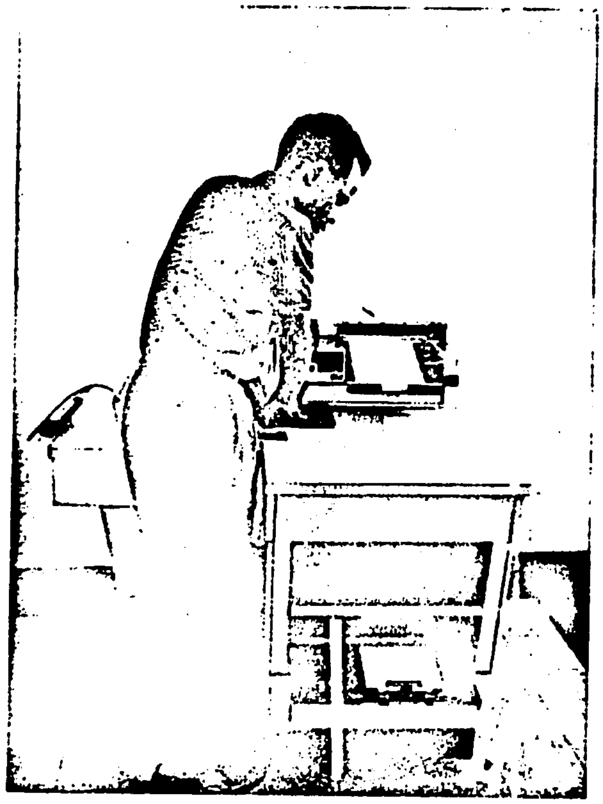

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