PD-AAI-746 662000105301
ISN 469

IMPLEMENTATION PLAN
FOOD CROPS RESEARCH CONTRACT
AFR-0001-C-00-1032-00
USAID/SECID - SEYCHELLES
Project No. 662 - 0001

INTRODUCTION:

The USAID/SECID team consisting of the Horticulturist, Plant Pathologist and Entomologist arrived in the Seychelles on July 13, 1981, after visiting the staff of REDSO, Nairobi. We were received by the Chief Research Officer (CRO) of the Department of Agriculture and Land Use (DOA) Grand Anse Experimental and Production Division (GAC). The CRO was extremely helpful in every way in assisting the American team to adapt quickly to a new environment and work assignment.

There were some initial logistical problems associated with procuring and preparing the facilities needed at GAC, but within a few weeks the team had adequate laboratory and office facilities and land for experimental work.

From the outset the CRO and his staff did all they could to create an environment which would lead to a close working relationship between the American team and our Seychellois counterparts. We were never treated as outsiders, and therefore, participated in the decision making process at GAC from the very beginning of the Contract.

We were impressed with the rapport which exists between the research staff at GAC, the extension personnel and the staff of the Farmer Training Center (FTC). From the beginning, we were invited to participate in weekly seminars which bring together the research, extension and training elements of the country to consider topics of major importance affecting agricultural development. In this way research developments of demonstrated value under local conditions can quickly reach the small farmers of the country. Peace Corps volunteers, working within the extension service, are helping to catalyze the link between research and extension. In the same way, the problems of small farmers are quickly brought to the attention of the research staff at GAC, which aids in the planning of research studies which are practically oriented toward the solution of these problems. In short, because of this close organization in a very small country, there is no reason for a communication gap to exist between research, extension, training and the small farmers of the Seychelles. It is this situation which greatly enhances the opportunities for the successful implementation of the Food Crops Research Contract.

ROLE OF HORTICULTURIST/ADVISOR AND CHIEF-OF-PARTY:

The Seychellois counterpart to the Chief-of-Party is the Chief Research Officer of GAC, who himself is a trained horticulturist. Thus, from the beginning of the contract, the Chief-of-Party had the special advantage of a close professional relationship with the CRO. The background and experience of the Chief-of-Party, who is the contract horticulturist, is related more to vegetable crops than fruit crops, while the CRO is a fruit

specialist. Thus, while the two scientists will work together on major horticultural crops of the Seychelles, each will assume individual responsibilities in his own particular field of expertise.

a. Developing Research Capabilities

Agricultural research in the Seychelles has been conducted sporatically over the years and most of it by the former colonial government. Agricultural research, in general, and horticultural research, in particular, is still in its "infancy." The "research" which was being conducted with horticultural crops when we arrived can best be described as unreplicated "trials" and "observations." Little or no attention has been given to the principles of experimental design, so the results of such "trials" are of questionable value.

The CRO is well aware of the deficiencies in the research program and the lack of training and experience among his young staff. Thus, one of the greatest contributions that the contract scientists can make is the "on-the-job" training of the young Seychellois scientists and technicians. This process has already begun in the disciplines of horticulture, plant pathology and entomology. One or more technicians have been assigned to each contract scientist on a full-time basis.

b. Effective Planning for Research

Under the "Scope of Work" section for the Horticulturist/Advisor, his role in assisting the CRO in planning and directing the research program at GAC is specifically listed as a responsibility of the position. This responsibility can not be overemphasized, because the achievement of all other objectives depends on effective planning which must emanate from the CRO's office. Fortunately, at the very beginning of the contract, the Horticulturist/Chief-of-Party was invited to join the CRO in the formulation of GAC plans for a research program. Research planning included the actual preparation of the 1982 GAC Budget, the development of an advanced training schedule for Seychellois staff under the Contract, and the determination of requirements for implements, materials, supplies and equipment for conducting horticultural research. The development of long range plans involved each of the contract scientists, except the soil scientist, who had not yet arrived. The Plant Pathologist and the Entomologist also contributed to the planning of a new laboratory at GAC.

c. Research in Horticulture

The Government of the Seychelles (GOS) through its Department of Agriculture and Land Use (DOA) is determined to move in the direction of self sufficiency in food crops. Some food crops, such as rice, cannot be efficiently produced in the Seychelles, and their production should not be attempted. Crops like most cereal grains, which require extensive, relatively flat land areas, have little chance for success in the Seychelles, where land area is very limited and slopes are extremely steep, except for a very narrow coastal strip. On the other

hand, crops such as some tropical fruits and vegetables, have an enormous potential in this small country. To develop this potential, a well organized applied research program is needed.

d. Elements of Horticultural Research Program

Work on most of the research activities in horticulture listed under the "Scope of Work" of the Food Crops Research Contract has begun and others will be initiated in the near future.

(i) Variety Testing:

Seeds of numerous commercial vegetable varieties and clonal material of the major fruit crops grown in the Seychelles, have been either purchased or donated by seed companies around the world. In the past, seeds have frequently been imported without regard to the adaptation of the crops to the environmental conditions of the islands, so variety trials of the important horticultural crops will be necessary in order to eveluate the performance of imported varieties. In each variety trial, a "standard" variety which is already commonly grown and known to be adapted to the environmental conditions of the Seychelles, will be used as the basis for comparison. Particular emphasis will be given to the degree of resistance to diseases and nematodes and the extent of insect damage of introduced cultivars. The contract pathologist, entomologist and soil scientist will cooperate in this work.

(ii) Training in Research Methodology:

As indicated above, one or more Seychellois technicians have already been assigned to work with each contract scientist. The Seychellois scientists and technicians are participating with us throughout the trials or experiments from the selection of an appropriate research design and the planning of the research study through to harvest and the analysis of the results.

(iii) Recording Data:

Recording growth data and observations is part of the research methodology that Seychellois scientists and technicians are learning through on-the-job training. The Seychellois technician, working with the contract horticulturist, records observations and data routinely on all trials and experiments. The types of data and observations the local staff are learning to record are not restricted to only growth records and the effects of "chemical applications" but include a whole range of information related to investigations into the major problems of producing fruits and vegetables under small farmer conditions.

(iv) Indexing system:

An indexing system for recording all food crop introductions at GAC has not yet been established, but this important responsibility will not be neglected. An organized indexing system is needed to replace the "haphazard" way in which seeds and clones of fruit and vegetable cultivars have been imported in the past.

The elements of a simple indexing system are: (a) careful records of every official entry of a crop species which is brought into the country (b) an accession book in which every official entry is recorded and numbered with an accession number, followed by the species, cultivar, source of origin and individual or agency requesting the importation.

In addition to the data which must be recorded when the crop species enters the country, a "feed-back" system is needed in which observations are later recorded in the accession book when the cultivar or clonal material has been grown and evaluated. The observations would include the performance, i.e. yield and quality, of the entry, its apparent suitability to local environmental conditions and observed characteristics such as disease and insect resistance or susceptibility. Finally, the disposition of the crop entry would be recorded, i.e. the "release date" if the entry was found suitable for multiplication or a note stating that the entry was discarded. The indexing system described above will begin with as many past crop introductions as possible for which information is available and continue with each new official crop entry.

(v) Seed and Clonal Multiplications:

Before seed multiplication of adapted varieties can be attempted, variety trials which have already begun, will have to be completed to determine which cultivars should be multiplied. GAC scientists, with our assistance, are already working with personnel of the extension service, who are in turn cooperating in research studies, including variety trials. As new proven varieties become available, seed and clonal material will be multiplied and distributed to farmers through the extension service.

(vi) Soil Analysis Laboratory:

At the time this report was prepared, the soil scientist had not yet arrived on location. However, some soils laboratory equipment has been ordered which will permit soils work to begin. Soil samples will be sent to the U. S. for analysis until a new soils laboratory is functional at the GAC.

When the soil scientist arrives, one of his first tasks will be to assist the CRO to plan a complete modern soils laboratory, which will provide GAC with the capability for both soil and plant tissue analysis. Since funding does not exist in the contract to build and fully equip a new soils laboratory, other sources of funding will have to be identified for the new GAC soils laboratory.

During the 12 months the soil scientist is in the Seychelles, he will train a Seychellois technician. When the soil scientist departs, the contract horticulturist will assist the technician to continue the operation of the soils laboratory.

(vii) Farmer's Field Days:

Farmers' field days are held once each month with the participation of the contract scientists, and are well attended. Each month a different topic is presented to farmers. Since we arrived in the Seychelles, field days have been held on root crops at GAC and at the Farmers' Training Center (FTC) on irrigation. The field days are an effective way of demonstrating new techniques to farmers and will continue on a regular basis.

(viii) Demonstration of Improved Practices:

The field days provide an excellent opportunity for demonstrating improved farming practices and improved cultivars to farmers. The FTC is directly involved because field days are held there. To date demonstrations have not yet been held on State Farms, but we have visited the State Farms and found the farm managers quite willing to cooperate. The contract pathologist has conducted a survey of the diseases of horticultural crops on one of the state farms.

Results of experiments in progress are still too preliminary to be demonstrated on farmers' fields. This is a critical step which should come at a later stage when we have proven results and improved techniques to offer farmers.

(ix) Preparation of Teaching Materials and Bulletins:

The preparation of teaching materials and bulletins has been planned but not yet started. One effort which will involve the contract horticulturist is a joint effort with the CRO on the preparation of a publication on "Vegetable Growing in the Seychelles."

(x) Material Requirements for Research Program:

One of the first duties of the contract horticulturist after the arrival of the American team, was to assist the CRO in determining requirements for implements, materials and supplies

necessary to conduct the horticultural research program at GAC (see above, "Effective Planning for Research.").

(xi) Linkages with Other Institutions:

The CRO has already visited several international agricultural research centers (IARC's), and will visit others for the purpose of "refresher training" and orientation programs, paid for by contract funds. GAC is now receiving genetic materials from the IARC's and other sources. We have also planned training for other Seychellois scientists and technicians at the IARC's, and linkages will be continually strengthened during the contract.

(xii) Scientific Conference:

GAC is interested in hosting a conference to share the results of its research program with other Indian Ocean countries. Such a conference will probably be organized during the last year of the contract when there are sufficient results from the research program to share with scientists from neighboring countries. The contract horticulturist, who is a member of the International Society for Horticultural Science (ISHS) will contact ISHS to determine the possibility of ISHS becoming a co-sponsor for such an international conference.

(xiii) Lectures in Horticulture:

Each of the contract scientists is participating in regular seminars held at GAC, but no formal lectures have been presented to date. Later in the contract, lectures in horticulture and related topics will be presented to FTC students and MOA extension staff.

(xiv) Technical Library:

The contract horticulturist and the CRO are jointly developing a list of publications, bulletins and journals needed to supplement the small technical library at GAC. A larger number of volumes are stored at the central DOA library in Victoria, which will eventually be consolidated into one agricultural library at GAC.

(xv) Peace Corps Volunteers (PCV's):

The contract horticulturist and the other contract scientists have been working with the PCV's since the beginning of the contract. Since PCV's are part of the extension service, this provides an important link between research and extension.

The Chief-of-Party recently met with the visiting Peace Corps Desk Officer concerning the recruitment of three new PCV's who are also expected to work in agriculture. The contract scientists will provide training for the new PCV's working with

the extension service. The contract is also prepared to provide whatever administrative backstopping and supervision is required throughout the contract.

e. DOA Objectives

DOA has stated its objective of sustained, year round production of horticultural crops. To investigate the potential for sustained production throughout the year, four basic comparisons must be made. The GAC research program with fruits and vegetables will compare results of variety trials and of cultural practices in two locations and soil types: (1) the relatively flat coastal plain with sandy somewhat saline soils and (2) the steep to very steep relatively cool hillsides with red clay to clay loam, acidic soils. The research effort will also compare results obtained with improved varieties of fruits and vegetables during the relatively dry, cool and cloudy southeast monsoons (May to October) with the same crops grown during the relatively rainy, hot and sunny northwest monsoons (November to April). The performance of a crop or a particular variety may be entirely different under each distinct set of environmental conditions.

The present situation with production of vegetable crops is extremely seasonal. Small farmers plant mainly in the southeast monsoons which creates an overproduction of fruits and especially vegetables during this period. This is followed by a period of scarcity of fresh produce and high prices during the northwest monsoons. The factors which contribute to this situation must be considered in the planning of the GAC research program. For example, hard driving rains during the northwest monsoons can damage young seedlings and the wet conditions can contribute to the rapid development of foliar diseases. Factors such as these add to the farmer's risk of crop failure and must be considered in order to achieve DOA's stated objective of sustained year round production of horticultural crops.

One major reason for the seasonality of horticultural crops in the Seychelles is the availability of water, which is another major concern of DOA. In a climate which would otherwise be suitable for year round production, water is frequently a limiting factor to the production of fruits and vegetables. Although Mahe receives over 100" of rainfall annually on parts of the island, the relatively poor distribution of rainfall on soils of low water-holding capacity leads to periods of extreme water stress and even drought. Irrigation is essential to achieve DOA's objective of year round production of horticultural crops. However, the cost of most modern irrigation equipment is prohibitive for the average small Seychellois farmer. Inexpensive means of irrigation which make efficient use of limited water supplies must be developed.

f. Cooperation with other GOS organizations

The implementation of the objectives of the Food Crops Research Contract will depend in part on cooperation with some other GOS organizations in addition to DOA. One example is the Seychelles Commodities Corporation (SEYCOM) a parastatal body which has been designated by GOS as the principal buyer of farm produce. SEYCOM has replaced the small produce "dealers" and "middle-men," who once bought produce from small farmers and sold to the commercial markets and hotels of Mahe.

Under the present system, SEYCOM trucks collect produce from small farmers in Mahe and nearby islands and pay a fixed price for each commodity. Fruits and vegetables are usually just dumped together in flat-bed trucks without the use of containers. The produce is often handled in this manner several times before it reaches the consumer so the damage and loss to fruits and vegetables is considerable. Storage facilities are totally inadequate, resulting in generally poor quality produce at the market. The distribution system also functions poorly, and shortages are common in the shops and town markets.

Recognizing the importance of what happens to the produce after harvest, a special meeting was called between DOA and SEYCOM, in which contract scientists participated. A number of major issues were discussed including: ways to improve the post-harvest handling of fruits and vegetables, development of a grading system and grade standards for produce, construction of storage facilities, pesticide residue problems, control of storage rots and diseases and the development of additional market outlets.

It was agreed that better quality control was needed for the benefit of both farmers and consumers and that exporting produce should not be considered until improved post-harvest handling of produce was achieved. It was also recognized that a system of grading requires a market which can utilize each of the various grades in order to avoid waste. Finally, the need for close cooperation between DOA and SEYCOM was recognized to be very important to the development of a horticultural industry in the country. As a result, a standing committee was organized to consider major issues on a regular basis. Contract scientists will serve on the joint committee in an advisory capacity.

g. Summary

The contract scientists on location in the Seychelles now have the advantage of several months of direct exposure to the major problems and factors limiting the production of horticultural crops. As a result of this initial experience and the association with our scientific colleagues at GAC, we are in a much better position than previously to determine how each of the project goals can be implemented. Work has begun on most of the specific items listed within the "Scope of Work" of each contract scientist. We can now

select areas for special emphasis within each of our disciplines which will provide the opportunity for the greatest impact on agricultrual production at the level of the small farmer.

The development of a well-organized, practically oriented research program with horticultural crops manned by Seychellois scientists and technicians is the key to the achievement of the stated GOS objective to move toward self-sufficiency in food crops. It is for this reason that the successful implementation of the contract objectives will depend more on what we can do to help develop the research capabilities of GAC, than on the research activities of each of the contract scientists individually.

ROLE OF PATHOLOGIST/ADVISOR:

a. Applied Research

(i) Disease Surveys: A fund of knowledge concerning plant diseases in the Seychelles and an understanding of the various crops and the diseases of the Seychelles is essential to the most effective organization and orientation of a program in plant pathology. Information available in GAC reports refers to many of the diseases of fruits, vegetable and spice crops of the Seychelles. Certain diseases may be present, however, which have not been identified or previously reported. Some diseases may vary in incidence and intensity between soils and/or between locations and/or between times of year.

Disease surveys will be initiated in order to identify the plant diseases of the crops of the Seychelles Islands and to obtain information on the importance of the different diseases at various locations at various times during the year. This segment of the program will be carried out in cooperation with the Pest Control Officer, and with Peace Corps volunteers and with Seychellois Extension Personnel. Visits will be made to various farms at different times of the year in order to identify the diseases of the major crops of the islands, to evaluate the potential economic losses from these diseases, and to determine the pathogens responsible for the diseases.

Photographic records of the various diseases will be made on two by two slides. Samples of diseased specimens will be returned to the laboratory for pathogen identification and verification of the organisms present as the causal agents of the various diseases.

(ii) Identification of Pathogens: The identification of a disease based entirely on the symptom response of the host may result in incorrect diagnosis.

There are many nematodes, fungi and bacteria, which have been found in association with symptoms of diseased plants, which have not been identified. Both primary and secondary symptoms occur on many host plants without the concommitent appearance of known pathogens. Many plants have been observed which manifest symptoms characteristic of virus diseases. The causal agents of these diseases have not been identified.

It will be necessary, consequently, to establish the identity of many of these suspected pathogens from diseased plants.

Unidentified fungi and bacteria from diseased plants will be cultured on laboratory media for observation and identification.

Homogenates from plants with virus-like symptoms will be employed to inoculate indicator plants in small screen cages. Symptom

response will be observed in order to attempt to establish the type of virus involved.

(iii) Rules of Proof of Pathogenicity:

Many of the diseases observed during the surveys conducted for the purpose of identifying plant disease problems in the Seychelles will not have a known causal agent. More than one suspected pathogen may be observed on some diseased plants. Consequently, studies will be required to determine the true pathogens of the various diseases in the Seychelles.

Microorganisms isolated into pure culture, or perpetuated on specific hosts in the case of obligate parasites, will be increased in culture (or on the host) and inoculated to host plants. Observations on the presence and appearance of symptoms will be recorded, microorganisms present on the diseased host will be isolated for identification. The completion of these rules of proof of pathogenicity will reveal whether or not the microorganism originally isolated is, in fact, the pathogen.

Crude homogenates of plant sap from plants with symptoms characteristic of virus-caused diseases will be used to inoculate healthy suscepts and indicator plants in order to determine whether or not a virus is involved in symptoms development, and to determine which virus is responsible for the symptoms.

(iv) Determination of losses from plant diseases:

A wide variety of diseases pose production problems to all of the crops in the Seychelles. Relatively little information is available, however, concerning the exact monetary losses attributable to the detrimental activities of pathogens on crop plants. An important aspect of this project will be determination of losses attributable to diseases of crop plants of the Seychelles.

Field soil with known nematode infestation will be treated with nematicides. The yields from plants in soil treated for nematode control will be compared with yields from plants on non-treated soils in order to obtain quantitative data on the potential losses of production.

In some cases losses can be estimated in the course of field surveys. This is especially true when the incidence and intensity of a given disease are given high ratings early in the development of the crop.

Comparisons of yields from diseased plants can be made with yields from adjacent symptomless plants in areas where the incidence (numbers of plants in the total population) of diseased plants is random. Yield reduction and resultant losses also can be calculated under field conditions in which a specific pathogen is

responsible for the mortality of any given percent of the host population.

Field research will be conducted in which fungicides will be employed for disease control. Comparisons of yields from sprayed plants with yields from unsprayed check plants will be used to obtain information concerning losses attributable to plant diseases.

(v) Development of Programs for control of Plant Pathogens:

(1) Introduced Plant Material.

Almost all of the crops grown in the Seychelles have been introduced. The majority of the pathogens occurring on these crops have been introduced along with their host plants. Every effort should be made to prevent the introduction of pathogens which currently do not occur in the Seychelles. This can best be accomplished by obtaining plant materials only from reputable sources, obtaining certification statements from suppliers that the propagating material is pathogen-free, accepting only seed that has been treated with fungicides, and growing introduced plant materials under quarantine for observation for the occurence of disease symptoms.

(2) Determination of Resistant Varieties.

Host resistance is one of the most effective and important methods of disease control available. Determination of resistance of various host plants to different pathogens will be approached in a variety of ways.

Resistance of host plants to root-knot nematodes will be determined by uprooting plants infected by root-knot nematodes and assigning a root-knot gall index rating to individual plants. The index value will reflect the intensity of disease (gall development). The values can then be used to compare different plants or different groups of plants for resistance to root-knot nematodes.

Resistance of host plants foliage pathogens is seldom absolute. Infection may have occurred in host tissue with the chemical or morphological defense mechanisms acting to restrict further invasion with the result that chlorotic local lesions (resistant reaction) may form, but no mature, sporulating lesions (susceptible reaction) develop. Disease index ratings will be developed to permit evaluation of all degrees of resistance to various foliage diseases.

These disease index ratings will be based on a 0 to 10 scale, where 0 indicates no disease. In some cases reference to levels or degrees of resistance will be incorporated into the

rating. This will involve a value to indicate whether or not the host plant is highly susceptible to highly resistant, or manifests a resistant reaction etc.

These rating systems will be employed to rate plants in variety trials and to obtain ratings on plants in farm plots which show varying levels of resistance to different diseases.

Different varieties in trials of chinese cabbage, cabbage, and tomatoes, which are to be planted at eight sites in the islands on twelve dates, will be evaluated for resistance employing this rating scheme. Differential response of varieties of vegetables to various disease-causing agents will be recorded from farm plots in order to accumulate additional information on resistance to the various pathogens.

(3) Plant Disease control by Vector Control.

The inoculum of many plant pathogens is disseminated or transmitted from infected host plants to healthy host plants by insect vectors. Any practices which can be employed to decrease vector populations or which would prevent successful transmission or dissemination of pathogens would constitute valuable control measures for the diseases. The application of petroleum hydrocarbons to cucumbers and watermelons has achieved some degree of control of water melon mosaic virus. Research on this aspect of control should be initiated as part of the project in the future. The use of insecticides to decrease populations of aphid vectors of viruses is another aspect of vector control which may warrant future consideration.

(4) Chemical control of Plant Diseases.

Fungicides and nematicides are routinely employed as integral portions of pest control programs by the majority of Seychellois farmers. Three or four fungicides are commonly employed at frequent intervals for disease control. Efficient control of these diseases may be attainable with fewer fungicides and/or with fewer applications.

Several fungicides recently have been introduced to the market which may provide better control of some diseases than materials currently available.

Field trials which Dithane M-45, Bravo, Benlate, Dilfolatan and a copper-containing fungicide for gray leaf mold and leaf spot control of tomatoes have been initiated as part of this research effort. The progress of disease development will be monitored by weekly disease ratings of all plots. Yield data will be taken in order to determine yield differences among

treatments, and between treatments and yields from the unsprayed check plots.

Black rot of cabbage, caused by Xanthomonas campestris, is a major problem in the Seychelles. Crop rotation, crop sanitation and pathogen-free seeds are control measures which will provide some control of this disease. The Seychellois small farmer devotes considerable time and effort to individual units in growing the vegetable crops of the islands. Control procedures for plant diseases, therefore, can be devised which involves individual plants. Trials should be initiated to determine the effects of soil treatments, such as formalin, on the incidence of black rot of cabbage. These trials could be carried out by identifying fields with a high incidence of disease. Soil treatment with chemicals would be applied to individual planting sites. Disease incidence and cabbage production from the treated sites would be compared with disease incidence and production from untreated sites.

Root-knot nematode (Meloidogyne sp.) is a serious problem in many areas of sandy soils in the Seychelles Islands. Nemacur currently is the nematicide of choice for control of root-knot nematodes. Other chemicals, such as EDB, Mocap, Vydate, Temik, methyl bromide and Telone II are potentially useful chemicals for nematode control.

Trials have been initiated in which vydate, Nemacur, EDB, Curraterr and vapam will be compared for efficiency of control of root-knot nematode on Vauvina variety tomatoes. Yield data from these trials, in addition, will provide essential information concerning losses attributable to root-knot nematodes on tomatoes.

Sufficient numbers of plants will be transplanted into the field plots to allow for nematode infection monitoring during the early stages of host plant development. Primary and secondary symptom development will be recorded as symptoms develop, and a root-knot index will be employed to register gall development and infection intensity on the roots.

Conversations with growers and with extension personnel indicate that the acreage of crops receiving pesticides has been increasing during the last few years. The number of applications per crop season and the array of different pesticides also have increased during the very recent past. Consequently, the quantity of pesticides entering the islands and the quantity applied have increased. The Contract Entomologists report refers to some of the consequences of the increase in use of insecticides.

Potential increase in the concentrations of some pesticides in the soil (and ultimately in water in some areas) and the disposal of unused portions of pesticides are

factors which can result in serious problems well into the future. Recommendations for use should emphasize the smallest effective quantity applied in the lowest number of applications. Pesticide orders should request the least amount of material required to satisfy the immediate objectives.

(5) Cultural Practices for Control of Plant Diseases.

Rogueing of plants with symptoms of virus infection is a cultural practice which is recommended in order to minimize the spread of viruses from plant to plant. This practice has been recommended for peppers and tomatoes in fields in farm plots with low incidences of virus infection, especially in the early stages of development of the crop.

Removal of host debris and thorough tilling of the soil has been recommended to growers with cabbage infected with *Xanthomonas campestris*, causing black rot disease.

Some success has been achieved in Israel in controlling root-knot nematodes of tomatoes with the use of plastic soil covering around the tomatoes. This implementation plan does not anticipate initiation of this type of research at this time, but effort should be undertaken on this aspect of control over the next year.

b. Training in the Basic Aspects of Plant Pathology

(i) Laboratory-Field Technician: Training in the basic laboratory and field techniques of plant pathology currently is being provided for one individual. Laboratory training is limited to making media. Pure culture techniques will be introduced as soon as materials and supplies become available. Training beyond this level is not considered feasible. Training on field research methods will involve field plot design and organization, land preparation, methods of plant culture and care, soil and foliage fungicide application methods, harvesting techniques, disease rating schemes, data taking and basic aspects of data analysis, such as averaging.

(ii) Professional Plant Pathologist: The research which has been initiated to date and which will be undertaken during the three-year term of this project should be the beginning of a continuing effort, and should form the nucleus of a program on plant pathology in the Seychelles for the future.

The permanent, full time employment of a scientist educated in the basic principles and trained in the applied aspects of the science of plant pathology, at a highly accredited University, will be essential for such a program to become a reality.

c. Communication of Research Results

(i) Extension:

(1) Grower Contacts.

Ideas and factual information on diseases and disease control have been communicated to all growers and farm managers visited to date. Information and knowledge concerning the nature of different diseases, as well as information on control, is presented during conversations with growers.

(2) Extension Contacts.

Contacts with extension personnel occur frequently, which allows for discussions of ideas concerning plant deseases and their control. The contacts include regular seminars at Grand Anse Center, monthly extension meetings at the Farmers Training Center and informal meetings on field days or disease surveys.

(3) Publications.

An article concerning tobacco was co-authored for the Nation. An article entitled "Plant Pathogens Affect the Welfare of Mankind" was published in the Nation. Articles on specific diseases will be written for release to extension workers and/or publication during the next six to eight months.

(4) Slide File.

The nucleus of a file of 2 x 2 color slides of plant diseases has been prepared. This file will be expanded with time. A publication employing these slides will be issued towards the mid-point of the contract.

ROLE OF ENTOMOLOGIST/ADVISOR

The short time which is allowed for development of entomological activities will necessarily restrict the scope and depth of these programs. However, under the direction of a highly motivated and aggressive Chief Research and Development Officer, and with an excellent Pest Control Research Officer, significant entomological activities can be developed and carried out. Information obtained should provide more effective, less expensive yet ecologically sound programs of insect pest management on fruits and vegetables. Research related to identification and control of insect and mite vectors of plant viruses will be conducted in close coordination with the Pest Control Research Officer and the plant pathologist.

It is obvious that, after assessing the plant pest situation here on Mahe and Praslin, plant diseases (and nematodes) in general, pose the most serious threat to most crops. However, there are many major insect and mite problems which necessitate development of sound control programs. As agricultural production increases, problems with arthropod pests will intensify. Thus more entomological input will be essential and close coordination of these activities with other crop portection disciplines will be necessary.

Some examples of major insect and mite pests which need serious consideration are as follows:

* Fruit flies, primarily the Mediterranean fruit fly, *Ceratitis capitata*, but other species may be present.

* The diamond back moth, *Plutella xylostella*, a serious pest to cabbage and water cress.

* The rose beetle, *Adoretus versutus*, a nocturnal foliage-feeding insect with a wide host range.

* Scale insects on many fruit and vegetable crops.

* Aphids, white flies, myrids and other potentially important plant virus vectors.

* Plant sucking bugs such as the complex of stink bugs and corieds (*Leptoglossus australis*) were recently found in extremely damaging numbers on margoze.

* Mites, particularly the red spider mite, *Tetranychus* sp., which are becoming more abundant on several crops with increased insecticide usage.

This fragmentary list does not in any way cover the wide range of arthropod pests associated with food crops in the Seychelles. However, it does provide a point of departure from which priorities can be set and research plans formulated.

After having the opportunity to visit many farms on Mahe and Praslin, and with the kind assistance of the research and extension personnel and the growers, the activities proposed below represent those which I feel can contribute most to the entomological effort under the terms of the contract.

a. Insect and Mite Survey, Collection and Identification

Although to date many farms on Mahe and Praslin have been visited and surveyed, these activities and discussions with growers will continue in order to keep abreast of their insect and mite problems. Determination of the species of insects and mites present on fruits and vegetables and the nature and extent of their damage will continue. Collections are being made from crops and also from a U.S.D.A. light trap which I shipped from the U.S. The trap is presently situated at the Farmer's Training Centre, Anse Boileau. From these surveys and collections, a permanent reference collection is being made. This will be used by personnel at the Grand Anse Agriculture and Land Use Experiment Station and for demonstrations and training in workshops, seminars, etc.

Species collected in the field or from light traps are either preserved directly in Schmidt boxes or in ethyl alcohol. Those arthropods which are difficult to identify as immatures, are reared to their adult form in the laboratory. Classification of many of the species is being facilitated by the resident Overseas Development Agency (U.K.) entomologist, who is sending some of the material to the British Museum identification.

b. Identification and Control of Arthropod Vectors of a Tomato Virus:

The experimental design and methods for conducting this work are in collaboration with the plant pathologist and Pest Control Research Officer. The widespread virus infestation on tomatoes on Mahe and Praslin seriously limits full production on many farms. The experimental design has been developed and the insect cages have been constructed. Small sleeve cages for confining suspected insect vectors also have been constructed.

Tomato seeds have been planted and pots containing the seedlings are being kept under insect-proof cages. Possible vectors will be collected from the tomato plants and from vegetation adjacent to tomato fields. Suspected insect vectors (e.g. small mirids, aphids, white flies, planthoppers, etc.) will be caged, using small sleeve cages on virus infected plants. After two or three days to allow time for the insects to feed, they will be transferred to the 2.5 x 2.5 x 2.5 ft. cages containing the virus-free tomato seedlings. Observations of possible virus symptoms will be carried out as plants grow and develop. Additional mechanical inoculations are planned by the plant pathologist.

The plant pathologist will be in charge of this experiment because most of the work will be conducted after the entomologist/advisor's

departure this year. Additional work on any modifications of the above experiment will be conducted next year upon his return.

c. Seasonal Abundance, Distribution and Control of Fruit Flies:

After surveying many farms on Mahe and Praslin it is apparent that fruit flies are one of the most important groups of insect pests. This also is evidenced by the increased number of complaints by farmers. The major species is the Mediterranean fruit fly (medfly) *Ceratitis capitata*, but it is probable that other species are present. Fruit flies attack a wide range of crops in the Seychelles. These include citrus, mango, guava, passion fruit and peppers.

In order to determine the seasonal abundance, distribution on Mahe and effectiveness of different insect traps, experiments have been designed in close collaboration with the Pest Control Research Officer. These experiments will incorporate the use of four different traps which will be located at eight different locations. The trap sites represent a range of elevations and proximities to fruit and vegetable growing areas. The four types of fruit fly traps are as follows:

(i) The standard plastic trap which has been used, is approximately 12 x 12 x 7 cm. These traps are either yellow or orange and will be baited with the attractant Trimedlure and charged with the insecticide Dipterex.

(ii) A flatter white trap (13 x 13 x 4.5 cm) will be baited with Trimedlure and the insecticide Dipterex.

(iii) The flat white trap containing Trimedlure and sticky panels inside without Dipterex and

(iv) Standard gypsy moth traps with Trimedlure.

Pilot studies recently conducted have shown that the gypsy moth trap is much more effective than the currently used trap for trapping medflies. However, its durability is questionable.

All traps will be checked one or two times per week throughout the year and the Trimedlure, insecticide, and sticky panels replaced as needed. In addition to using the attractant Trimedlure for the medfly, Cue Lure for several *Dacus* spp. and methyl eugenol will be placed in 30 traps in order to determine if other species of fruit flies are present.

Concurrent collections of fruit and peppers will be made from areas where traps are located. These fruit-fly infested fruit will be placed in trays which already have been constructed. These trays are especially designed for emergence and pupation of fruit fly larvae. As fruit fly larvae leave the fruit and pupate in the sand contained in the trays, they will be sieved from the sand and placed in small containers for emergence of the adults. Percent emergence and species determination will be made.

Fruit fly trapping sites have been located and three of the four types of traps are now in place. Thus, already information is being gathered on the distribution and abundance of fruit flies on Mahe.

These dates will provide important basic information necessary for designing a control program for this pest. Results from work conducted in the Southeastern U.S. have revealed that near eradication of the medfly using poison baits, is possible. Further work, using this approach along with continued trapping and campaigns to dispose of dropped fruit, is planned during the second year of this contract.

I have received recent correspondence from scientists at the Commonwealth Institute of Biological Control related to obtaining medfly parasites from Kenya. The possibilities of introduction of these parasites into the Seychelles is being investigated.

d. Biological Control of the Diamond Back Moth, *Plutella xylostella*, on Cabbage

The diamond back moth, *Plutella xylostella*, is the most serious insect pest of cabbage in the Seychelles. Currently, repeated applications of the insecticides Lannate, Decis or *Bacillus thuringiensis* is the usual practice for control of this pest. Recently, however, several growers have indicated poor control with Lannate. This strongly suggests that *P. xylostella* is becoming resistant to this chemical. Thus this compound may soon be lost as an effective control agent. Likewise, frequent applications of the synthetic pyrethroid, Decis, also may induce resistance in this pest. A possible alternative to the exclusive use of Lannate of Decis is biological control. However, formulation and implementation of a biological control program will require careful stepwise planning and execution of research in order to allow biological control agents time to become established and reach densities which are effective.

According to records at the Agriculture and Land Use Experiment Station, Grand Anse, at least three species of parasites of *P. xylostella* were introduced into the Seychelles from the West Indies during 1972. These species were: *Apanteles plutellae*, *A. vestalis* and *Thyraeela collaris*.

Recent correspondence with scientists at Commonwealth Institue of Biological Control, suggested that no follow-up work has been done on these parasites. In a report on a visit to the Seychelles in 1977, one entomologist with C.I.B.C. strongly supports the idea of possible biological control of the diamond back moth.

With this background information, a pilot program of possible biological control of the diamond back moth on cabbage is being initiated. Plans include establishment of a small (1/8 hectare) plot of cabbage on the Experiment Station Farm and at other locations if possible. This will be done in order to find out whether any of the

previously released parasites have become established. From the unsprayed cabbage field, samples of P. xylostella larvae and pupae will be taken on a weekly basis and brought to the laboratory. Here they will be reared to adults be feeding them artifical media or cabbage. The incidence of parasitism and parasite species will be determined.

After developing baseline data on the natural incidence of parasitism, possibilities of introducing more parasites will be investigated. Use of the parasites plus the microbial insecticide, Bacillus thuringiensis, will be the only approaches employed in the proposed experimental program.

A continuous crop of cabbage will be grown in order to allow parasite numbers to increase. This should be carried out for at least two years.

During later stages of the experiment, sequential sampling programs will be initiated in order to make application of B. thuringiensis only when necessary. Release of the parasites on the small plot of untreated cabbage coupled with use of the microbial insecticide should allow assessment of the potential for complete biological control of this pest on grower's farms. Important considerations for this program would be to plant cabbages where chemical spray drift from other crops is minimized. Also, unless P. xylostella and the associate parasites have alternate hosts or cabbage is grown continuously, re-introduction of the parasites occasionally may be necessary. If the program is successful on a "pilot" basis at the Experiment Station, trials will be extended to selected grower's farms. Education of the growers to the necessity for sampling their cabbage field in order to determine if damaging levels of P. xylostella are present will be critical to the success of the program. Sequential sampling plans are currently being designed for this purpose.

According to earlier reports, parasitism of the diamond back moth was 45% by A. plutellae in Barbados while A. plutellae and Thyraeela collaris combined to parasitize 80% of the diamond back moths in Zambia. We are optimistic that with the introduction and establishment of these parasites along with use of the microbial agent B. thuringiensis, control of P. xylostella can be less expensive, permanent and more ecologically compatible than the current chemical control methods.

e. Observations and Field Notes

The suggested areas of investigation outlined above are those that are deemed most urgent after consultation with the Chief Research Officer, the Pest Control Research Officer, and Chief-of-Party. In addition, discussions with other key extension and Peace Corps personnel have been extremely helpful in helping to identify problems and establish research priorities. The growers have been extremely cooperative and helpful and eager to learn of new information relative to insect

control. Recently, the entomologist/advisor has been working with two young Seychellois trainees who have shown a keen interest in entomology. He has attempted to provide as much training as possible during the time that they assisted him. It would be useful if a short term training period in the U.S. could be worked out for them. Insect control in the Seychelles is almost entirely carried out by applications of chemical insecticides. Some results of using this approach alone are evident. First, suspected resistance by Plutella xylostella to the insecticide Lannate (Methomyl). Secondly, pests which were not economically important are being elevated to primary status. Examples of this are outbreaks of spider mites, Tetranychus sp., in beans, peppers and watermelons and increased populations of the caterpillar, Spodoptera litteralis, on cabbage. Programs should be initiated to remove crop residues from fields. For example, bean plants which have finished producing, should be removed in order to prevent the build up and spread of mites and the bean pod borer, Maruca testalalus.

Currently a cannery is being constructed on Mahe which should greatly improve the sale of fruits and vegetables and thereby encourage increased productions. However, production of certain of these products may be limited by lack of adequate control methods for selected pests. For instance, there is an apparent increase in the intensity of attacks by fruit flies, especially on passion fruit, capsicums, and citrus fruit.

The rose chafer, Adoretus versutus, is a serious defoliator of many plants. Efforts will need to be focused on its biology and control during the course of this contract. Likewise insects such as mole crickets, especially important in some areas where seedlings are in beds, should be carefully investigated.

Spodoptera sp. larvae have heretofore not been reported to attack cabbage in Seychelles and flea beetles were found attacking the leaves of sweet potatoes. The importance of this damage has not been assessed but dense populations of these beetles cause extensive scarring of the leaf surface area.

Pyralid larvae were found in high numbers on sweet pototo foliage near Anse Aux Pins, Mahe. This pest could be potentially serious and should be carefully studied.

There are many other entomological problems which need attention. However, with the limited time alloted for the entomologist under this contract, programs in this area are confined to the more urgent problems. It would be desirable to substantially increase the entomological component of the contract in order to develop sound integrated pest management programs which are tailored to increase food production and meet the needs of Seychelles farmers.