Conclusions and Recommendations
from Technical Events Series
A2/TT - 86 - 001

ISSN - 0253 - 4746

PESTS AND DISEASES AS CONSTRAINTS IN THE PRODUCTION AND MARKETING OF FRUITS IN THE CARIBBEAN

PROCEEDINGS OF A SEMINAR ON PESTS AND DISEASES AS CONSTRAINTS IN THE PRODUCTION AND MARKETING OF FRUITS IN THE CARIBBEAN HELD IN BARBADOS, WEST INDIES FROM SEPTEMBER 29TH TO OCTOBER 3RD, 1985

Edited by
Chelston W.D. Brathwaite, Rafael Marte and Edgar Porsche

IICA

Offices in Barbados and Trinidad & Tobago

Port-of-Spain, Trinidad & Tobago, October 1986

PESTS AND DISEASES AS CONSTRAINTS IN THE PRODUCTION AND MARKETING OF FRUITS IN THE CARIBBEAN

Proceedings of a Seminar
held in
Barbados from September 29 to October 3rd, 1985

Edited by

Chelston W.D. Brathwaite, Ph.D.
Regional Plant Protection Specialist
and Director of the IICA Office
in Trinidad and Tobago,

Rafael Marte, Ph.D.
Fruit Specialist
IICA Office in Barbados

and

Edgar Porsche
Peace Corps Volunteer
IICA Office in Barbados

TABLE OF CONTENTS

	PAGE
Preface	i
Acknowledgements	ii
Opening Remarks:- Michael J. Moran	1
Address:- The Honourable Richard L. Cheltenham	4
Scope and Objectives:- Chelston W. D. Brathwaite	8
The Fruit Plant Propagation and its relation with the prevention of Pest and Diseases:- Rafael Marte	11
Insect Pest as Constraints to the Production of Fruits in the Caribbean:- Gene V. Pollard & Eslie H. Alleyne	31
Disease as Constraints in the Production of Fruit Crops in the Caribbean:- Ralph Phelps	62
Plant Quarantine Requirements for the Marketing of Fruits in the Caribbean:- Charles Y. L. Schotman	76
Alternatives to EDB Situation Studies of Quarantine and Pest:- Robert Strong	82
Methods and Techniques for Alleviating Postharvest Problems in Fruit Marketing:- Ena C. Harvey	91
Economic Implications of Pests and Disease in Fruit Marketing in the Caribbean:- Michael J. Moran	120
COUNTRY PAPERS	
Barbados:- Jeffrey E. Jones, Omer S. Thomas and Stevenson Skeete	136
Grenada:- Paul R. Graham	174
Dominica:- Hannah Claredon	185
Guyana:- Janice Gittens	204
St. Lucia:- Dunley Auguste	219
Suriname:- Frederik W. Soerodimedjo	233
Trinidad & Tobago:- Lennox Andrews	242
Recommendations of the Seminar	260
List of Participants	265
Abbreviations	270
Vernacular and Latin Names	272

PREFACE

In spite of efforts to develop tourism, manufacturing and non-agricultural activities, agriculture continues to be a major source of income, employment and foreign exchange for many countries of the Caribbean. In recent years, attempts to diversify and expand the production of non-traditional crops has resulted in major emphasis on fruits, vegetables and foliage for both local consumption and export markets. This has resulted in the need to import new germplasm and to reduce losses from pests and diseases both in the field and after harvest. In addition, the strigent requirements of foreign markets makes it necessary to enforce strict quarantine legislation in countries of origin.

The seminar held in Barbados in 1985 sought to identify those pests and diseases which might act as constraints to the production and marketing of fruits in the region.

It is hoped that these proceedings will serve as the beginning of cooperative efforts designed to remove these non-tariff barriers, reduce losses and facilitate the production and marketing of fruits in the Caribbean.

ACKNOWLEDGEMENTS

The editors acknowledge the cooperation of the Ministry of Agriculture and Natural Resources of Barbados for the efforts which made the seminar possible especially the staff of the Soil Conservation Unit, the Plant Pathology and Entomology sections and the Public Information section of the Ministry, the various country participants for presenting papers and the specially invited resource personnel for their contributions. The logistic support of the staff of the IICA Office in Barbados especially the secretarial assistance of Miss Sandra Best is also gratefully acknowledged.

OPENING REMARKS

by

Michael J. Moran, Director, IICA Office in Barbados

Mr. Minister, Hon. Dr. Cheltenham, ladies and gentlemen, colleagues, this seminar "Pests and Diseases as Constraints in the Production and Marketing of Fruits in the Caribbean," is a response to Caribbean country needs. This area is of high priority in most countries as expressed by:

- Significant capital investments in fruit crop production over the past five years.

- The large number of small farmers growing fruit trees and the importance such economic activity can have on employment.

- The need to generate foreign exchange, achieve import substitution of food items whenever economical.

- Improved nutritional levels, and the importance of fruit trees in soil conservation practices.

All of this investment which runs into millions of dollars, needs to be protected. Plant protection then, from pests and diseases must be viewed from an integrated approach - from seed to consumer.

We need to take a multidisciplinary approach to pests and disease problems as they affect fruit at the plant propagation level, production, marketing and other post-harvest stages.

As the fruit industry becomes more important from a socio-economic point of view, meaning jobs and income, the protection of the overall investment and expected returns becomes more critical.

The main problem is as fruit production intensifies, the greater the probability of pest and disease outbreaks and the need for control. As transportation and trade increases, improved guarantees and quality control measures are required.

What is at stake?

If pest and disease are not controlled and improved management practices implemented in the production and marketing of fruits, market rejection can occur. We need only to recall the case of mango seed weevil and medfly problems.

Other issues at stake are poor quality resulting in low prices or total rejection by buyers and consumers. Rejection in the market or regulatory agencies may occur when the improper chemicals are used.

Ultimately, the loss of jobs, markets, income and access to food can result.

There are many ongoing initiatives directly dealing with pest and disease problems in the Caribbean, both at the national and regional levels. IICA has responded to country requests through our plant protection, production and marketing programmes. Others such as BDD, AID, EEC, FAO, CDB. CARDI, University of the West Indies and others also are providing significant assistance .

What is needed may be called a risk-sharing attitude related to the developing of improved pest and disease programmes related to fruit production and marketing. This seminar is one such important step which we will collectively seek to:

- Develop an awareness of an integrated approach.

- Identify major constraints and discuss their economic implications.

- Identify areas of priority research and actions for cooperation among production, marketing and plant protection specialists.

The real challenge is to identify concrete follow-up joint action areas that are possible, not ideal.

I welcome all of you and wish you success in meeting the objectives of the seminar and look forward to a frank and professional interaction among all.

FEATURE ADDRESS

by

Dr. The Honourable Richard L. Cheltenham
Minister of Agriculture and Natural Resources

Mr. Chairman, Mr. Moran, Distinguished guests, participants, ladies and gentlemen:

I join Messrs. Jeffers and Moran in extending a very warm welcome to all of you, especially to our visitors from abroad.

The whole area of fruit pests and control is one which is ideally suited for regional cooperation and collaboration and so it is with pleasure that I note there are participants from a wide cross-section of the region among us.

I am happy especially to address this seminar since it deals with fruit development, an area of agriculture to which I am particularly attracted and to which my Ministry is giving priority attention.

The Inter-American Institute for Cooperation on Agriculture has been engaged in some very effective fruit development activities in Barbados and I have every confidence that under its technical guidance, we can all look forward to making positive headway in tackling the theme of the seminar - Pests and diseases as constraints in the production and marketing of fruits in the Caribbean.

In November last year, the Inter-American Institute for Cooperation on Agriculture, in collaboration with my Ministry, organised a three-day fruit exposition at Graeme Hall, the Ministry's headquarters. This exposition demonstrated the variety of fruits that can be grown locally. It also served to highlight and illustrate both the nutritional value and the economic value of fruits.

In 1984 the value of fruit both fresh and processed imported into Barbados was nine million two hundred and eleven thousand three hundred and ninety-nine Barbados dollars. This represented an increase of four hundred and nineteen Barbados dollars over the 1983 figures. These figures show that there is significant room for import substitution while maintaining a vigorous regional trade in fruit when the seasonality of fruit production is taken into account.

All this potential would be placed at risk if we do not pay due attention to establishing and maintaining proper and adequate plant protection and plant quarantine arrangements.

Examining the objectives of this seminar it is observed that you hope to do several things:

(a) identify further methods of controlling pests and diseases, (b) examine the impact of pests and disease on the marketing of fruit, both regionally and extra-regionally, (c) improve the basis for inter-country cooperation so as to prevent the movement of fruit pests and diseases in the region and (d) identify the plant quarantine requirements for the export of fruit within the Caribbean and to North American markets.

To this end you will be addressing a number of topics relating to pests and diseases constraints in the production and marketing of fruits in the Caribbean. As I understand it all aspects of production will be examined, that is, production from the nursery stage to the market stage. My technical officers have advised me that there are pests and diseases which have not presently been found in Barbados but which constitute potential risks to fruit development in the region. I refer especially to pests such as the mango seed weevil which has been found in St. Lucia and the French Islands of Martinique and Guadeloupe; the citrus canker which was reported to be in Florida earlier this year; and to a lesser extent to the Moko disease in bananas.

I would now like to clarify our position with respect to the action taken by my Ministry to prohibit the importation of mangoes from those countries where the Mango Seed Weevil is present. Given our emphasis on fruit production, it is in our interest to keep all pests and diseases outside our shores. Besides, I have been advised that if Mango Seed Weevil were discovered in Barbados, then its presence would have a damaging effect on any fruits which we are likely to export to the United States of America. Hence, it is regretted that a decision had to be made to prohibit temporarily the importation of mangoes from those countries where this pest was present. I trust that you will appreciate that although we realised the hardships this decision would have caused intinerant traders, prohibiting the importation of mangoes is the only method of controlling this pest. I hope that the rationale for taking this action is now fully understood.

Another matter of significant importance to which you will be attending is the plant quarantine requirements for the marketing of fruit in the Caribbean. It is with pleasure that I commend the Executive Committee and the Technical Secretary of the Caribbean Plant Protection Commission of FAO for their efforts to harmonise the plant quarantine legislation in the Region. Plant quarantine as you are aware, is our first line of defense and we are always looking at ways and means to improve this service. We therefore understand that you will be taking a detailed look at the FAO Model Plant Quarantine legislation. We are aware that some persons take pleasure in falsifying phytosanitary certificates accompanying fruits which are imported and we must make an effort to stamp out this illicit practice.

This brings me to another aspect on which the Seminar will focus. It is methods and techniques used for alleviating post-harvest problems in fruit marketing. It is noted that you will be giving consideration to fruits such as citrus, mango, avocado, pawpaws, cherries, golden apple, anonaceous fruits and other non-traditional species in which we have potential for export. We must not forget that all the care taken in producing a good crop may be lost through poor harvesting techniques and post-harvest handling. Remember that the post-harvest techniques

employed and marketing are dependant upon each other and your returns on a crop are effected by the quality of the produce which you offer your customers.

Before closing I wish to publicly express my appreciation to IICA for co-sponsoring this seminar.

I shall be looking forward with interest to the results of your deliberations and wish all of you who are visitors a very pleasant stay in Barbados.

THE SCOPE AND OBJECTIVE

by

Chelston W.D. Brathwaite
Regional Plant Protection Specialist
IICA - Trinidad and Tobago

This Seminar arose out of the discussion held between the personnel of IICA Plant Protection Programme and IICA fruit development project in Barbados and the basic idea was endorsed by the Heads of Plant Protection of the Caribbean as recommendation No. 7 at their meeting in Barbados last year.

The seminar seeks to:

- Develop an awareness of those pests and disease which limit the production of fruits in the Region.

- Identify methods of controlling these pests and diseased.

- Examine the impact of pests and diseased on the marketing of fruits, both Regionally and extra-Regionally.

- Provide a basis for inter-country cooperation in preventing the movement of fruit pests and diseased in the Region.

- Identify the plant quarantine requirements for the export of fruit both within the Caribbean and in North American Markets.

The seminar was formulated on the following premises that:

- The fruit subsector can make a significant contribution in the agricultural diversification efforts of member states of the Caribbean.

- Pests and disease can represent significant non-tariff barriers to regional and extra-regional trade.

- The recent decision to remove barriers to intra-regional trade in primary agricultural products in the Caribbean increases the risk of spread of plant pests and diseases.

- There are significant resources available in the region for control of fruit pests and diseases. The resources of CARIRI, CARDI, UWI, FAO, APHIS/USDA and IICA are being utilized in this seminar.

- Regional cooperation can be more effective than individual efforts of member states.

The Seminar recognized that the opportunities which have become available under the CBI and the Lome III can be nullified by non-tariff barriers such as pests and diseases unless steps are taken to remove these potential constraints to marketing of fruit.

Last year, the IICA plant protection programme cooperated with the USDA and APHIS authorities in the establishment of proposals for carrying out a survey of certain islands in the Caribbean for incidence of fruit flies. Since then a protocol has been drawn up with the respective countries for implementation of this project. Should the results of the survey show the absence of fruit flies, there will be a basis for the entry of fruit from these countries into the United States markets.

It must be emphasised that pest and disease incidence are dynamic occurrences and consequently the absence of fruit flies today, does not mean their absence next year and it will be necessary for the respective

countries to put in place the relevant quarantine infrastructure to ensure that their countries remain free of pests.

The importance of pests and diseases in production and marketing is sometimes under-estimated and it is necessary to refer to concrete examples to make the point. The case of Moko disease of banana which was discovered for the first time in Grenada in 1978 provides an excellent example of the kinds of problems diseases can cause. According to a report by Dr. Gene Pollard, Moko disease has so far cost the Grenadian authorities $5 million for its control and it still poses a serious threat to the banana industry in that country and in the Eastern Caribbean.

I hope that the seminar will achieve its objectives and I welcome all of you.

THE FRUIT PLANT PROPAGATION PROCESS AND ITS RELATION WITH THE PREVENTION OF PESTS AND DISEASES

by

Rafael Marte
Fruit Specialist, IICA Barbados

1. INTRODUCTION

I am sure that many of you are wondering why, in a seminar dealing with pests and diseases of fruits, the area of propagation has been included. Farmers, and even we as technicians, have a tendency to think, that the problem of pests and diseases is a problem of the orchard. Similarly, when we talk about the control of those problems, immediately we think of the use of pesticides, and in the best of cases, the use of resistant varieties.

Not many people realize that many of the problems of pests and diseases found to be affecting the orchard today, were initiated at the propagation stage of the individual plant. In other words, not only can plant pests and diseases develop, but in many cases they can be prevented in the early stages by the selection of proper seeds. For example, virus diseases can be prevented, to some extent, by a proper selection of resistant rootstock (i.e. Citrus). A plant known to be contaminated by virus particles, can now be propagated "virus free" by the use of tissue culture. Apomitical embryos are also known to come not only true to type, but also virus free. Since it is not only with viruses where the propagation aspects are important but similarly,it is with other diseases and pests caused by fungi, bacteria, mycoplasma and insects.

The use of a contaminated soil medium in the propagation of a given fruit tree, may also be the cause of many costly problems later in the field. The sterilization process of the medium to be used in the propagation process is also important in the control of pests and diseases.

Contaminated fruits will lead to contaminated seeds as well but the treatment of the seed before being planted prevents most problems. The selection of a proper sterilization process is important to guarantee: (a) the complete decontamination and (b) no adverse effect on the germination of the seed. One treatment may be effective against a particular problem, but not against the others. Further, a given product may be effective against certain pests and diseases but its use may kill the seed or reduce its viability.

On the other hand, there is a common mistake in the assumption that because plant material is brought into a given country with the proper phytosanitary certification, or because it came from a research station, the safety of the material is guaranteed. Most of the phytosanitary certificates are issued at the seaport and airport by 'qualified personnel' who examine the material by visual observation. However, many problems such as virus and virus-like diseases cannot be detected no matter how close these 'qualified personnel' examine the material to be exported. The source of the plant material to be propagated is one of the most important factors to consider in the prevention of plant pest and diseases. These are only a few examples of the importance of the propagation process in the prevention of many problems which later may be found affecting the plants in an orchard.

2. FACTORS RELATED TO PLANT PROPAGATION AFFECTING THE INCIDENCE OF PESTS AND DISEASES IN THE NURSERY

Nursery stock is a primary means by which new or harmful fruit pests and diseases may be introduced or spread within any given area. Pests and diseases threaten to infect nursery plants at any given moment, from the selection of the seed up to the time when the tree is ready to be planted in the field. The detrimental effect of insects, bacteria, fungi, viruses, nematodes, weeds and other parasites must be well understood by the nursery man to avoid irresponsible sales, that may constitute the hazard of introducing, maintaining or spreading the problem.

Pests and diseases not only reduce tree vigour and decrease yield but also shorten the tree life and significantly affect fruit quality.

There are many factors which affect the incidence of pests & diseases in the nursery. To facilitate their discussion we have classified them as follows:

- The method of propagation of tropical fruit trees.
- The source of the seeds and the budwood.
- The handling of the seed in the nursery.
- The soil medium for seedbeds and pots.
- The seedbed location and construction.
- The irrigation method and amount of moisture.
- The distribution of plants in the nursery.

2.1 THE METHOD OF PROPAGATION

There are three methods of propagation.

2.1.1 Sexual Propagation Cycle

Consists of the propagation of plants by using the seed they produce. By this method, new individual offsprings are created whose characteristics reflect the genetic combination of the two parents.

The propagation by sexual method (seeds) is, by and large, the most usual and economical method of propagation. Most viruses affecting fruit species are not transmitted by seeds. However, the advantages of other methods have been

replacing seed propagation use in many instances.

Fruits such as papaya, which come into bearing in a relatively short period of time are entirely propagated by this method. Also, most of the plants used as rootstocks are propagated by seeds. But when quality, resistance, precocity and uniformity want to be combined then seed propagation by itself is not the answer.

2.1.2 Asexual Propagation Cycle

These methods of propagation utilize vegetative parts by which the unique characteristics of the plant being propagated, are preserved in the offspring. Also the genotype of the mother plant (source of the material being propagated)is preserved intact.

The asexual propagation could involve one (1) and two (2) parted trees.

The methods of asexual propagation most commonly used for 'one part' fruit trees and a typical example of species propagated by these methods are indicated below.

Method	Fruit Species
Suckers (also slips or crowns)	: Pineapples
Layering	: Nutmeg, limes
Cuttings	: Cherries, breadfruits, citrus
Meristem culture (tissue culture)	: Citrus, papayas

The plant propagated by asexual methods in one-part trees is on its own roots. Here the combination of characteristics such as quality, yield, resistance to pests & diseases, adaptability to the ecology (climate & soil) must be in the only existent part, different from two parted trees as it is discussed later.

On the other hand, two parted trees are structures composed of two individual parts: The 'Scion' and the 'Stock'. They are genetically different but living symbiotically, and their combination influences, to some extent, the performance of both. The scion, in general, is selected for yield, quality of the fruit (external and internal), acceptability in the existing markets and tolerance or resistance to climate, pests and diseases (see complete detail in Appendix no.1). The rootstock is selected basically for its influence to the scion in yield and quality, and also for their influence on the resistance or adaptability to soil-borne problems including pests, diseases, drought, waterlogging, and other physical and chemical problems in the soil in general.

The most common asexual propagation methods used in fruits for 'Two-Parted Trees' are listed below:

<u>Grafting</u>

- Cleft: Avocados, sapodilla, mangoes
- Side: Mangoes, avocados, sour sop, carambola
- Veneer: Mangoes, avocados, sour sop, carambola sapodilla
- Approach: Mangoes, citrus

- Bark: Most fruit species when 'top worked'

Budding

- T-Budding: Citrus
- Chip budding: Cherries, Sour Sop, Avocadoes, Mangoes Citrus.

Micropropagation:

Apical Meristem micrografting: Citrus

A considerable amount of work has been conducted in the screening of stocks to overcome problems of pest and diseases. Without any doubt, most of the information available on fruits is for citrus species. Table 1 presents a list of the problems overcome with the use of stocks in citrus and some others whose resistance is not known yet.

2.1.3 Apomitical Propagation Cycle

In this type of propagation, the embryo originates directly from cells of the mother plant by vegetative or asexual process within the seed, in which there is no participation of the union between male and female cells.

Because the embryo originates from meristematic tissues, the resulting plant is considered 'virus free'. Also, the originating plant is genetically the same as the mother plant.

Most citruses are polyembrionics, and the development of apomitical embryos from the seed is the major reason for the uniformity in characteristics of most of the progenies. The same also applied when considering the propagation by seed of citrus stocks. The apomitical propagation cycle is then an asexual propagation through the seed.

TABLE 1. Problems that can be wholly or partially overcome with rootstock or potentially with a rootstock solution.

I. Soil Related

A. Chemical

Saline soils	Excess boron
Calcareous soils	Mineral uptake
Excess copper[1]	

B. Physical

Soil texture (clay versus sand)
Excess water
Deficient water

C. Diseases

Phyophthora	Armillaria[2]
Clitocybe[2]	

D. Insects

Root weevils (fuller, blue green, Puerto Rican sugar cane stalk borer weevil)[3]

E. Nematodes

Tylenchulus semipenentrans (citrus nematode
Radopholus similis (Borrowing nematode)

II. Rootstock - scion related

A. Viruses

Tristeza	*Exocortis*
Xyloporosis (cachexia)	

B. Height of budding

Tree virog	Dwarfing
Fruit yield	Fruit size
Fruity quality	Cold tolerance

---

[1] No tolerance known
[2] No resistance known
[3] Currently no resistance to these problems

The fact scions are also the result of horticultural selections of desirable cultivars, and therefore uniform, plus the apomitical origin of most of the stocks, gives as a result citrus orchards that are in fact highly uniform to the inherited genetic characteristic of the tree components. This situation is desirable, if considering the similarity of cultural practices to be applied and the final products to be obtained. But, at the same time, might expose the orchard to endemic affliction by a large number of parasites.

2.2 THE SOURCE OF SEEDS AND BUDWOOD

The ideal condition could be to have selections of cultivars, clones or lines of fruits which have resistance to all the given pests & diseases, and to the ecological problems of the area where the orchard is to be established. In practice, however, this is impossible. The screening of the material available to satisfy "most of our needs" is the realistic approach.

When selecting the source of the seeds to be used as the definite one-part plant (plant in its own roots) it is necessary to consider, not only factors of resistance to pests and diseases and soil/water problems, but also quality and yield. However when selecting seeds for rootstock, the combination scion-stocks must be considered. In the former all the characteristic to be selected are in only one component while in the latter these characteristics are influenced by the combination scion-stock and the genetic make up of the two individual parts.

The source of the seeds and budwood is of high importance to determine the purity of the cultivar, but also the "cleanness" of the material. Let's discuss the source from two different angles:

- Local source

- Foreign source

2.2.1 Local Sources

In the English-speaking Caribbean there is a common situation when considering sources of seeds:

> "The seeds are bought from the public rather than having collection of plants established for that purpose. If however, this collection exists, it is characterized by the lack of care and consequently there is no guarantee of purity and cleanness of the products".

Such a situation is aggravated by the fact that because of the relative high price of fruits in this region, the common practice is to buy the seed rather than the fruit, to save funds. This is especially true for species such as mangoes, avocados, etc. In general those seeds come from fruits which have been in contact with the soil or, the seeds by themselves are collected from the ground after the fruits have rotted or animals have feed on them. The effect of this situation is that pests & diseases readily contaminate these fruits and then they may be introduced to the nursery through the seed. This is the major reason why in the propagation of fruit trees, it is always recommended that the needed seeds, be collected from fruit harvested at maturity from the tree.

On the other hand, most of the countries in the region have a museum of cultivars as sources of budwood but they are characterized by two conditions:

- The lack of care of the plants.
- The sources of the original plants introduced are not reliable.

With few exceptions if any, "Museums" or germplasm bank of fruits in the Caribbean are not receiving the attention that they require. They will be the focus of infestation and

spread of pests and diseases to the commercial orchard. The original sources of the plants established in these museums in the majority of cases will be from abroad, and in many cases these sources are not reliable in terms of cleanness as we discuss in the next point.

2.2.2 Foreign Sources

The common mistake and assumption that because the source of a given plant material is a research station, the safety of the material is guaranteed, is one of the major reasons of the introduction of pests and diseases particularly virus and virus-like diseases in the Caribbean. Most of the time phytosanitary certification is issued by "Qualified Personnel" at the seaport and airport, who only examine the plant material by visual observation. If this "Qualified" person is observing the material closely, the magic word of the exporter or importer will come out. "This material comes from "X Research Station" and the phytosanitary certificate will be issued. But it happens, that not all pests and diseases can be detected by traditional methods, and less by visual observation. The only relative safety is, if the material comes from a "Budwood Registration & Certification Programme" with the appropriate certification. However the safety will be only for the pests or pathogen for which certification was provided. Start searching in your particular country. You will find that only few of the introduced citrus species, come from such places.

The establishment of a good source of seeds and budwood is one of the major needs of the region and one area in which regional cooperation is feasible.

2.3 HANDLING OF THE SEED IN THE NURSERY

When fruits are collected for seeds they should be extracted as soon as possible to avoid possible contamination. The wrong practice of taking the fruits into the nursery and leaving them to overmature in order to facilitate the extraction of the seeds is a common practice in most of the various fruit nurseries in the Caribbean. Rotten fruits attract pests and diseases, then the seeds are contaminated. This situation is aggravated by the fact, that the collected fruits are usually left at places where the sun, rain and wind decompose them. They later will be a focus of possible contamination. The recommended practice is to harvest the fruit at full maturity to facilitate the extraction of seeds as soon as possible. If there is any place on the nursery, protected and isolated from where the plants are being, propagated, all the fruits can be placed there and the extraction of the seed should proceed at the earliest time possible.

There is always the possibility that some of the fruits harvested might be infested with pests and diseases. During the transport and handling, the pathogen or pest could affect other fruits that were originally 'clean'. It is important to treat the seeds at the nursery before they are stored or planted. Seed treatment can be done by dipping the seeds into hot water or using chemicals (see Section 3.2 below).

The seed, once extracted, if they are to be in storage for sometime, should be treated with some seed treatment chemical to protect them from further contamination. They also should be kept in a cool place with low humidity, to avoid their breakdown and contamination.

2.4 THE SOIL MEDIUM FOR SEEDBEDS AND POTS

The mixture of media for seedbed and pots is an essential part of the plant propagation process. These materials provide a proper

environment for the germination of the seed and root development, supply and hold the nutrients and moisture for the growth of the seedling, and of course, they are the bases for the support or initial anchorage of the plant. This mixture is variable in the nature and proportion of their components, the most popular ones being: sand, peat, soil, sphagnum moss, vermiculite, perlite, compost, bark, sawdust and wood shavings. Some of these materials are sterile product by their nature, but others are very exposed to the contamination by pests and diseases. Soil, for instance, is a major focus of contamination for the numerous pests, fungi, bacteria, nematodes, weeds and other organisms found living and propagating in it.

The preplanting treatment of the soil mixture for the seedbed and the pots is today a precondition for a successful operation in plant propagation of fruit trees. Various methods for preplanting treatment of soil mixture are today in use. The most important are: heat treatment (steam, hot air, fire), chemical fumigation (Formaldehyde, Methyl bromide, Chloropicrin, Vapam, Basamid, etc) and soil drenches (Dexon, Terraclor, Benomyl, etc). Complete details are given in the prevention methods under Section 3 below.

The amount of salts in the medium mixture is also a factor to consider, since they may build up to toxic levels affecting the root system, weaken the defense mechanism of the plants and thus facilitating the penetration by parasitic organism.

2.5 THE SEEDBED LOCATION AND CONSTRUCTION

When looking for a place to allocate the seedbed several factors should be taken into consideration in order to avoid contamination of the young seedling by pests and diseases.

- Seedbeds should not be located inside orchards. The mature plants are sources of infection and inoculum of diseases or the larvae and adult of pests which will easily affect the young seedlings, are very difficult to control under these circumstances.

- Places which present problems of waterlogging should be avoided since this condition facilitates the infection by pests and diseases.

- The border of the seedbed should be concreted but not the bottom. This facilitates drainage and avoids waterlogging in case of heavy rain or overirrigation.

- Borders of the seedbed should be raised 25 to 30 cm from the level of the soil. Blocks are excellent for purpose. This prevents to some extent the contamination from one seedbed to the other.

2.6 THE IRRIGATION METHODS AND AMOUNT OF MOISTURE

Water is essential for plant growth, but as with other factors it has its limit. High moisture (both humidity of the environment and moisture in the medium) contribute to the increase of infection by pest and diseases of the nursery plants. The proper timing of irrigation should be established by close observation or by using simple devices such as soil moisture meters (Tensiometers).

Excessive moisture combined with poor drainage promote root rot at all stages of development of the plant. High humidity in the air favor not only the development, but also the rapid spread of diseases such as damping-off, fruit and leaf spots and decay.

Sometimes the method of irrigation is responsible for the spread of diseases in the nursery. Overhead irrigation, for instance, has to be checked and adjusted periodically to avoid the splash of soil caused when heavy droplets hit the soil mixture of the pots or the seedbed.

2.7 THE DISTRIBUTION OF FRUIT PLANTS IN THE NURSERY

Plants in the nursery should be distributed in such a way, that aeration is facilitated and high humidity avoided. Crowding of seedlings or nursery plants facilitate the propagation and spread of propagules of paratitic organism because of the high humidity. This situation promotes the direct contact of the foliage and the lack of aeration in general.

The distribution of fruit species in the nursery should be done according to their requirements of humidity, sunlight, etc. Citrus plants for instance suffer when kept under saram shade for long periods of time thus becoming more susceptible to attack by mites, aphids, and leaf spots and causing organism.

3. PREVENTION METHODS TO GET 'CLEAN' FRUIT NURSERY PLANTS

Nursery plants may introduce pathogen or other pests to a property, through rooted, or seedling plants used as rootstock or definite plants. For instance, citrus stocks when transplanted to the nursery, may carry nematodes which later may affect the yield of the orchard. *Phytophthora cinnamomi* the causal agent of the avocado root rot, can easily be introduced in the transplanted plant, and even in the seeds. The risk of infection by serious viruses and virus-like diseases is also of primary importance.

This introduction of pests and diseases into the orchard must be prevented to avoid detrimental effects that later may cause catastrophic disaster to the production of fruits in the area. There, the importance of the prevention methods to apply, through the process

of plant propagation which are discussed below, is as follows:

3.1 THE SOURCES OF BUDWOOD AND SEEDS

The importance of a good source for budwood and seed was explained earlier in this paper. A good source is the first step to produce a clean plant.

If well-maintained local sources are not available, the best sources to get plant material from abroad are through the Budwood Registration and Certification Programmes. They guarantee that the material they provide, is clean from the virus and virus-like diseases and other pathogen for which they provide certification. These programmes are based on frequent inspection of the plants, indexing of possible virus and virus-like diseases, and the utilization of processes to clean the good genetic material from virus and virus-like diseases. Some of the processes applied to obtain virus-free plants are:

- Apomitical propagation.
- Apical meristem micrografting.
- Tissue culture.
- Heat therapy.

3.2 TREATMENT OF THE SEED AND THE SOIL MEDIUM

The treatment of the seeds before planting, is one of the most useful methods used to prevent early attacks by pests and diseases, and prevent the spread of these parasitic organism in the nursery, and from there to the orchard.

Seeds might be treated with heat, chemical products or both. The most common heat treatment is to dip the seeds in hot water for

a given time which varies with the fruit species. Citrus seeds, for instance are treated by dipping them in hot water at 52°C. for 10 minutes to eliminate the propagules of *Phytophthora* sp. Avocados seeds are treated in water bath at 49 - 50°C for 30 minutes and then cooled in cold water.

Chemicals such as Arasan, Captan and Benomyl are useful in the treatments of fruit seeds, especially if they are to be in storage for some time before planting. The preplanting treatment of the soil mixture is as important as the seed treatment. Methods include heat and chemical products in a wide range.

Steam is the best and most common heat source for soil treatment, but other sources as hot air and fire are also being used. In heating the soil a temperature of 82°c (180°F) for 30 minutes is the standard recommendation. At this temperature and time most harmful bacteria, fungi, nematodes and insects as well as most weed seeds will be killed (see Figure 1).

However, one must consider the beneficial organism in the soil, and the toxicity problems because of the release of excess ammonia and nitrite, as well as manganese injury which is often encountered at these high temperatures.

Fumigation with chemicals kills the organism without disrupting the physical and chemical characteristics of the soil mixture. The most common chemical used for this purpose are shown on Table 2.

TABLE 2: Soil sterilization by chemical product, dosage and application

Product	Dosage	More Effective Against	Remarks
Methyl Bromide			
	1.5lb/10m^2	Fungi, Bacteria, Insects, Nematodes and Weeds.	Leave plastic cover for two days after application. Ready to plant in five days.
Vapam	1lt/50lts water/10m^2	Fungi, Nematodes and Weeds.	Spray solution with water can and irrigate with plenty of H_2O after. Cover with plastic and leave two more days before planting.
Formaldehyde	1lt/50lts H_2O/10m^2	Fungi and Seeds of Weeds.	Apply with water can, irrigate with plenty of H_2O. Cover with plastic and leave 24 hours. Uncover and remove soil. Plant after 2 weeks or after the odour of gases has disappeared.
Basamid	50gr/m^2	Bacteria, Fungi, Insects, Nematodes and Weeds.	Distribute uniformily then irrigate. Cover with plastic. Uncover at the 4th day; irrigate again and cover. 7 days after, uncover and remove soil. Do not plant before 7 days more (19 days after application).
Chloroprin(teargas)	5ml/cu.ft	Fungi, Bacteria, Nematodes, Insects, some Weeds	Sprinkling water to Soil surface and then cover with plastic. Uncover 3 days after. Do not plant before 10 days after.

Some chemicals are available in formulation to be used as soil drenches. They inhibit the growth of many soil-borne fungi when applied to the soil mixture where young nursery plants are grown. Examples of these chemical products are:

Terraclor (Pentachloronitrobenzene): Effective against soil-borne fungi such as Rhizoctonia. It is almost insoluble in H_2O and therefore has a long residual effect. It may remain effective from 6 to 12 months.

Dexon (P-dimethylaminobenzene diazo sodium sulfonate). Controls water molds, Phytophthora and Pythium.

Benomyl Systemic fungicide which inhibits growth of Rhizoctonia, Fusarium, Verticillium and many other soil pathogens.

3.3 NURSERY INSPECTION

The hazards of introducing or harboring serious pests and diseases which may accompany nursery plants, have been emphasized several times throughout this paper. Frequent nursery inspection is a prevention method to stop any given pest or disease in the nursery in the early stage. These inspections should be based primarily in the pest and disease potential of any area where the stock plants are grown. However, it should consider pests & diseases occurring in the places from where the budwood and seeds were collected. The concept of a modern nursery inspection goes further than the simple act of actual survey, detection or suppression. The risk offered by pests and diseases stresses the need for weighing carefully the selection of the site for the nursery. All known procedures should be considered to exclude, or prevent, any harmful pest or diseases in the area of a prospective growing ground.

BIBLIOGRAPHY

1. ALDRICH, R.A. and P.E. Nelson 1969. Equipment for aerated steam treatment of small quantities of soil and soil mixes. Plant Dis. Rpt., 53(10): 784-788.

2. ALLEN, R.M., 1968. Survival time of exocortis virus of citrus on contaminated knife blades. Plant Dis. Reptr. 52:935-39.

3. ANONYMOUS. 1969 (Florida). Citrus Budwood Registration Program. Statement of policy. Florida Dept, Agr., Citrus Budwood Registration, Winter Haven, Fla. 10 pp. (Mimeographed).

4. BAKER, K.F., P.A. CHANDLER, R.D. DURBIN, D.J. FERGUSON, J.W. HUFFMAN, O.A. MATKIN, D.E. MUNNECKE, C.N. ROISTACHER, W.R. SCHOONOVER and R.H. CHIARONI, 1957. The U.C. system for producting healthy container-grown plants. Univ. Calif. Manual 23, 332pp.

5. BOODLEY J.W., R. SHELDRAKE Jr., Cornell. 1964 "Peat-Lite" mixes for container growing. Dept., Flor. and Orn. Hort., Cornell University, Mimeo Rpt.

6. BRAZELTON, R.W., 1968. Sterlizing soil mixes with earated steam, Agric. Eng., 49(7): 400-401.

7. BRIDGES, G.B. 1974. The Florida Citrus Budwood Program, In: JACKSON, L.K., A.H. KREZDORN and J. SOULE (eds.). Proc. 1st Intern. Citrus Short Course - Citrus rootstocks. pp 131-136, Florida Coop. Ext. Service, Inst. Food and Agr. Sci., Univ. Fla. Gainesville, Fla.

8. CALAVAN, E.C. 1958. Importance of virus diseases. Calif. Citrog. 43:230.

9. CHILDS, J.F.L., J. BOVE, E.C. CALAVAN, L.R. FRASER, L.C. KNORR, F. NOUR-ELDIN, A.A. SALIBE, S. TANAKA, and L.G. WEATHERS, (eds.). 1968. Indexing procedures for 15 virus diseased of citrus trees. U.S. Dept. Agr., Agr. Res. Serv., Agr. Handbook 333, Washington, D.C. 96pp.

10. FLEMING, G., AND C.E. HESS, 1965. The isolation of a damping-off inhibitor from spagnum moss, Proc. Inter. Plant Prop. Soc., 14:153-54.

11. GARNSEY. S.M., and J.W. JONES, 1967. Mechanical transmission of exocortis virus with contaminated budding tools. Plant Dis. Reptr. 51:410-13.

12. GIACOMETTI, D.C., AND D. RIOS-CASTANA, 1967. Programa de certificacion de yemas para la propagacion de citricos en Colombia. Rev. Agr. Tropical 23:277-87.

13. HARRIS, R.W., D. LONG, and W.B. DAVIS, 1967. Root problems in nursery liner production. Calif. Agr. Ext. AXT-244.

14. HARTMAN, HUDSON and Dale KESTER, 1975. Plant Propagation Principles and Practices. New York: Prentice-Hall, Inc. 662p.

15. KRUSE, P.F. and M.K.PATTERSON, (eds.) 1973. Tissue cultire methods and applications. New York: Acedemic press 527p.

16. MUNNECKE, D.E, 1957. Chemical treatment of nursery soils. Section 11 in Calif. Agr. Exp. Sta. Man. 23.

17. RICHARDS, S.J., J.E. WARNEKE and F.K. ALJIBURY, 1964. Physical properities of soil mixes used by nurseries, Calif. Agr., (18(5):12-13.

18. ROISTACHER, C.N., and K.F.BAKER 1954. Disinfesting action of wood preservatives on plant containers. Phytopathology 44:65-69.

19. SCHOONOVER, W.R., and R.H. SCIARONI, 1957. The solinity problem in nurseries. Section 4 in Calif. Agr. Exp. Sta. Mon.23.

20. TIMMER, L.W. 1974. The Texas Budwood Certification Program- An Autopsy. In: Jackson, L.K., A.H. Krezdorn, and J. Soule (eds.) Proc. 1st Inter. Citrus Short Course - Citrus rootstocks, Pp. 146-49. Fla. Coop. Ext. Service, Inst. Food and Agr. Sci., Univ. Florida Gainesville, Fla.,

21. VAARTAJA, O., Chemical treatment of seedbeds to control nursery diseases. 1964. Bot. Rev., 30:1-91.

22. WIEBE, J. 1958. Phytotoxicity as a result of heat treatment of soil, Proc. Amer. Soc. Hort. Sci., 72:331-38.

INSECT PESTS AS CONSTRAINTS TO THE PRODUCTION OF FRUITS IN THE CARIBBEAN

by

Gene V. Pollard

Department of Plant Science and Biochemistry
The University of the West Indies
St. Augustine, Trinidad W.I.

and

Eslie H. Alleyne

Ministry of Agriculture and Natural Resources,
P.O. Box 505, Graeme Hall,
Christ Church, Barbados, W.I.

1. INTRODUCTION

Throughout the English-speaking Caribbean islands, there is a very strong disposition towards fruit production in greater commercial quantities, both as fresh fruit for local and export markets as well as for processing. Fruit production (exclusive of the traditional cash crops of citrus and banana) has remained mainly a backyard enterprise except for small acreages of papaya, mangoes and avocado in some islands. Despite this, however, some farmers do produce sufficient fruit via these backyard gardens to earn significant income and, in some instances, even some foreign exchange. In one report, for example, it was shown that St. Vincent exported 572,803 kg avocados and 596,925 kg mangoes to the English-speaking Caribbean over the period 1979-1981 to the value of EC$226,485 (US$84,500) and EC$418,720 (US$156,200) respectively (Pollard, 1983). Grenada also exports a significant quantity of fruit to Trinidad as Simeon (1983) has shown (Table 1). For the three-year period under consideration fruit exports to Trinidad totalled EC$1,888,241 (US$704,568).

Table 1. Fresh fruits exported from Grenada to Trinidad (Simeon, 1983) by quantity, value and kind of fruit.

	QUANTITY (in kg)			VALUE (in EC$)		
	1977	1978	1979	1977	1978	1979
Avocados	7,523	266,820	112,198	10,129	359,246	251,834
Sour Sops	23,909	148,116	215,394	14,279	87,981	477,651
Mangoes	1,932	20,115	55,179	956	9,957	144,216
Sugar Apples	3,818	73,285	49,250	4,090	29,030	148,223
Sapodillas	6,955	28,982	126,323	4,731	17,215	217,604
Tamarinds	5,584	8,705	18,591	5,554	10,341	39,387
Limes	2,759	29,097	54,665	1,365	14,404	40,048

While the system of backyard fruit production is one in which pest populations will naturally tend to be kept at low levels, it is well documented that a shift to large monocultural systems is one mechanism which allows an insect species to achieve major pest status (e.g. Pimentel, 1977), Hence, one can safely predict that any increase in acreage of fruit production in the region will result in increased pest status of existing species and even the attainment of this pest status by species which previously were not pests. To prevent this, one has to ensure that adequate preventative pest management programmes are developed and instituted as one component of any scheme for increased fruit production.

In a general sense one can envisage a tremendous potential for nearly any of the traditionally grown fruits in the region. However, within the various agricultural research institutions in the region including Ministries of Agriculture, an expertise has been built up for certain of these traditionally grown fruits viz pineapple, mangoes, papaya, guava, avocado, citrus and banana. In some islands farmers have developed their own expertise in some crops. In Trinidad, for example, farmers have been producing tremendous quantities of watermelon. Besides those crops listed above there are others which should be considered for increased production e.g. passion fruit and various

annonaceous and sapotaceous species. A listing of some of the pests attacking some commonly grown fruits is given in Table 2. A more specific pest spectrum is given as well for those fruits species dealt with in greater detail in this paper.

2. MANGO - (*Mangifera indica* L.)

Wyniger (1962) and Hill (1975) have both listed a number of major and minor pests of mango. The majority of these, however, are only listed for the Old World. This could simply be a reflection of the fact that mango has been traditionally a more important crop in Asia and India, for example, then in the Americas. Vevai (1971) reports that in India there are 583,760 ha under mango cultivation. This is many times more than the total acreage under all fruit production in the English-speaking Caribbean.

Of those pests listed by Wyniger (1962) and Hill (1975) one, the mango seed weevil (*Sternochetus mangiferae* (F.)), has recently been recorded for the Caribbean and certainly poses a serious threat, not only directly to mango production but also because it is a pest of quarantine importance.

Table 3 lists some major pests of mango in the region. Of those pests listed tephritid fruits flies should be considered to be potentially the most serious. The various fruit fly species found in the Caribbean are listed separately (Table 4). There are 18 *Anastrepha* spp. reported so far in addition to *Lucumaphila acidusa* and *Toxotrypana curvicauda*. While mango is listed as a host plant of many of these, *A. obligua* (= *A. mombinpraeoptans*) is perhaps the most important pest species. Recent observations in St. Kitts, for example, has indicated an almost 100 per cent infestation level in some areas; and what is of serious concern as well, is that not only the local varieties are being attacked but also the hybrid or "grafted" cultivars like Julie, for example.

Of the other pests listed in Table 2, scale insects may frequently be quite important (Table 3). Generally these pests feed on young leaves, though flowers and young fruit may also be attacked. Leaves usually turn yellow and brown as a result of feeding; leaf fall then occurs. Heavy infestation leads to sooty mold fungal growth. The combination of this, in addition to direct feeding of these pests, may cause serious effects on the growth of the plant.

Two thrips species *Selenothrips rubrocinctus* and *Heliothrips haemorrhoidalis* attack mangoes grown in this area. The first sites of attack are the leaves which go bronze and eventually wither and fall. Damage to fruit also occurs and is similar to that on avocado fruit. Severe bronzing of the skin occurs and the damage may be so severe that cracking of the skin may result. If such mangoes remain attached to the plant, it is difficult to determine whether they are ripe. Even when fully ripened the discoloured skin makes them unmarketable. *Eriophyes mangiferae* is a rust mite which also causes a bronzing to both leaves and mango fruit.

The mango weevil is one of the newest pests to have been reported in the region. So far it has only been reported for Guadeloupe, Martinique and St. Lucia. Usually there are no external signs of infestation or damage to fruit although seed viability is greatly reduced since the larvae live and feed in the seed. Hill (1975), however, has reported that infestation of this pest leads to lower yields than normal. Of greater impact could be considered the loss in trade which results from the presence of this pest since the mango seed weevil must be considered a pests of plant quarantine importance for the region at this time. This would have implications for the movement of fruit from these countries. For example, mangoes from St. Lucia were prohibited entry into Barbados, one of its traditional markets, once St. Lucia had reported the presence of the mango seed weevil in 1984. Entry into the U.S.A. will also be affected.

able 2. A general listing of pests attacking a number of commonly grown fruits in the Caribbean region.

	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
UCKING TYPES										
Aphids										
Aphis gossypii - cotton aphid; melon aphid	+	+			+					+
Aphis spiraecola - spirea aphid; green aphid	+				+					+
Macrosiphum euphoriae - potato aphid								+		
Myzus persicae - green peach aphid								+		
Toxoptera aurantii - Black citrus aphid	+				+		+			
Toxaptera citricidus Tropical aphid					+					
Leafhopper and bugs										
Antillormenis barbadensis				+						
Campylenchia bastata					+					
Empoasca fabae - Potato leafhopper										+
Empoasca papayae - Papaya leafhopper								+		
Empoasca stevensii								+		
Morimdea cubrosa				+						
Nezara viridula - southern green stink bug	+	+	+	+	+	+	+	+	+	+
Phytocoris sp.				+						
Mealy bugs										
Dactylopius sp.						+				
Dysmicoccus brevipes - Pineapple mealy bug							+		+	

Table 2. (continued)

	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
Mealy bugs										
Ferrisia virgata - Striped mealy bug		+								
Leptoglossus gonagra						+				
Nipaecoccus nipae - Coconut mealy bug		+				+				
Planococcus (Pseudococcus) citri - Citrus mealy bug	+	+			+		+	+	+	+
Pseudaonidia trilobitiformis					+		+			
Psendococcus adonidum					+					
Pseudococcus longispinus					+					
Scales										
Aonidiella aurantii - California red scale	+				+					
Aonidomytilus albus - Cassava scale					+					
Aspidiotus articulatus - West Indian red scale		+		+	+					
Aspidiotus boweryi						+				
Aspidiotus cydoniae						+				
Aspidiotus destructor - Coconut scale		+	+		+	+	+	+		+
Aspidiotus hederae		+								
Aspidiotus lataniae										+
Aspidiotus nerii - Oleander scale					+		+			
Aspidiotus longispina								+		
Aspidiotus personatus - Masked aspidiotus		+					+			

Table 2. (Continued)

Scales	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
Asterolecanium pustulans - Oleander pit scale			+				+			
Aulacaspis mangiferae							+	+		
Aulacaspis rosae - Rose scale				+			+			
Ceroplastes ceriferes					+	+	+			
Ceroplastes denudatus										+
Ceroplastes floridensis - Florida wax scale				+	+	+	+			
Ceroputo barberii					+	+				
Chionaspis monir						+				
Chionaspis unilateralis						+				
Chrysomphalus dictyospermi - Dictyospermum scale		+			+		+			
Chrysomphalus ficus (C. aonidum) Florida red scale	+	+	+		+	+	+			
Chrysomphalus personatus							+			
Chloropulvinaria spp.							+			
Coccus hesperidium - Brown soft scale		+		+	+	+	+	+		
Coccus mangiferae Mango shield scale			+				+			
Coccus longulus - Long shell scale						+		+		
Coccus viridis - Green coffee scale; soft green scale				+	+	+				
Collaspis hypochlora				+	+					
Daclylopius nipae		+		+	+					+
Diaspis amydali					+					
Diaspis bromliae									+	

Table 2. (Continued)

Scales	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
Diaspis pentagona - West Indian peach scale								+		
Diaspis rosae							+			
Dicalothris lacvicollis										+
Dorthesia citri					+					
Geococcus radicum										
Hemiberlesia longispina								+		
Icerua montserratensis					+					
Icerya purchasi - Cottony Cusion scale					+	+	+			
Icerya rosae				+	+					
Insulaspis gloverii - Citris snow scale				+	+		+			
Ischnaspis insularis					+					
Ischnaspis longirostris - Black thread scale					+	+	+			+
Lecanium corni - Fruit lecanium		+								
Lecanium filiicum		+			+	+				
Lecanium hemisphaeicum					+		+			
Lecanium mangiferae - Mango shield scale			+				+			
Lecanium punctatum					+					
Lepidosaphes beckii - Purple scale; Mussel scale					+					
Orthezia insignis - Greenhouse orthezia				+	+					
Orthezia praelonga				+	+					
Orthezia sp. nr. molinarii				+						
Parlotoria pergandei					+					

Table 2. (Continued)

	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
Scales										
Parlotoria zizyphi					+					
Protopulvinaria pyriformis - Pyriform scale		+			+		+			
Pseudaulacaspis pentagona - White peach scale								+		
Pulvinaria ficius		+			+					
Pulvinaria psidii - Green shield scale					+	+	+			
Pulvinaria phriformis		+			+	+	+			
Saissetia coffeae	+			+	+	+	+			+
Saissetia hemispherica - Brown shield scale	+	+		+	+					
Saissetia neglecta		+		+	+	+				
Saissetia nigra - Hibiscus shield scale; Nigra scale					+	+				
Saissetia oleae - Black shield scale; Olive scale		+		+	+	+				
Selenaspidius articulatus - West Indian red scale					+					
Vinsonia stellifer - Glassy scale							+			
Unaspis citri					+		+			
White Flies										
Aleurocanthus woglumi - Citrus black fly	+	+					+		+	+
Aleurodicuus coccois		+					+			
Aleyrodes flocculus					+					
Aleyrodes goyabae		+								+
Aleyrodes howardi					+					
Aleyrodes signifera		+					+			
Aleyrodes sp.				+						+

Table 2. (continued)

	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
White Flies										
Dialeurodes citri Citrus white fly					+					
Dialeurodes citrifolii					+					
Trialeaurodes floridensis - Avocado white fly		+								
Thrips										
Corynothrips stenopterus								+		
Dicaiothrips brevicollis							+			
Dicaiothrips laevicollus							+			
Frankliniella insularis				+	+	+	+	+		
Heliothrips haemorrhoidalis - Greenhouse thrips		+			+	+	+			
Selenothrips rubrocinctus - Redhanded thrips; cacao thrips		+			+	+	+			
Symphyothrips punctalis					+		+			
Thrips tabacci - Onion thrips		+					+	+	+	
Mites										
Brevipalpus phoenicus - False spider mite					+	+		+		
Eriophyes mangiferae							+			
Eriophyes oleivora - Rust mite						+				
Eutetranychus orientalis								+		
Oligonychis mangiferus							+			
Phyllocoptruta oleivora		+			+					
Tetranychus urticae - Two spotted spider mite					+			+		

Table 2. (Continued)

	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
CHEWING TYPES										
Beetles										
Apate monachus					+					
Batocera rubus					+					
Cholus sp.									+	
Clemora smithi					+					
Cratosomus punctulatus					+					
Cryphalus sp.							+			
Diaprepes abbreviatus - Sugar cane Root borer	+				+					
Diaprepes famelicus					+					
Elaphidion mite - Twig borer of limes					+					
Exophthalmus spp. - Fiddler beetle					+	+				
Hyocryphalus mangiferae							+			
Lachnopus sp.					+					
Lachosterna spp.					+				+	
Lepturges guadeloupennis							+			
Leptostylus praemorrus - Bark borer					+					
Metamasmius ritchei									+	
Neocyphus pudens					+					
Pachnaeus spp. - Citrus root weevil					+					
Phyllophaga citri					+					
Rhabdochemis obsura - Hawaiian sugar-cane borer								+		
Sternochetus mangiferae - Mango seed weevil							+			

Table 2. (continued)

	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
Beetles										
Steriasoma breve					+					
Xyleborus confusus							+			
Xylosandrus campactus					+					
Termites and ants; wasps										
Acromyrmex octospinosus					+		+			
Atta sephalotes					+		+			
Atta insularis					+					
Atta laevigta					+					
Atta sexdens					+					
Azteca sp.					+					
Bephrata maculicollis - Soursop wasp										+
Crematogaster sp.		+		+			+			
Microcerotermes		+								
Nasutitermes aboreus		+			+					
Solenopis germinata - fire ant		+			+					
Butterflies and moths										
Argyotanenia amantana	+									
Camilla fusca										
Cerconota anonella - Soursop moth				+						+
Heliothis armigera					+					
Heliothis zea - Corn earworm								+		
Oiketicus abotti		+								
Papilio anchisiades - Orange dog					+					
Papilio andraemar					+					

Table 2. (continued)

	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
Butterflies and moths										
Papilio peleus					+					
Papilio thoas melonius					+					
Spodoptera spp. - armyworm, tomato fruit worm			+					+		
Thecla ortygnus								+		
Thecla brasiliodes									+	
Tmolus echion									+	
Xyleutes punctifer		+			+					
Fruit flies[1]										
Anastrepha spp.				+	+	+	+			
Ceratitis capitata - Mediterranean fruit fly					+	+	+			
Toxotrypana curvicauda - Papaya fruit fly								+		
OTHER PEST SPECIES										
Slugs and Snails										
Pleurodonte isabella					+					
Strophocheitus oblongus			+		+	+				
Veronicella laevis		+	+	+	+	+				
Birds										
Coereba flaveola - Bananaquit, Sucrier					+	+	+	+		
Loxigilla noctis - Red brest					+	+	+	+		
Thraupis episcopus - Blue bird, Blue Jean				+		+	+	+		+

[1] See table 4.

Table 2. (continued)

	Golden Apple	Avocado	Breadfruit	Cherry	Citrus	Guava	Mango	Paw Paw	Pineapple	Soursop
Birds										
Turdus nudigenis - Big-eye Grieve				+		+	+	+		+

Table 3. Major insect pests attacking mango

Anastrepha spp. *(Diptera, Tephritidae)*	Fruitfly	Larvae tunnel and feed in flesh; mature fruit with rotting spots or punctures and fruit fall.
Aspidiotus destructor Sign. *(Homoptera, Diaspididae)*	Coconut scale	Scales on surface of leaves; these eventually go yellow to brown and fall; sooty mold infestation.
Coccus mangiferae (Green) *(Homoptera, Coccidae)*	Mango soft scale	Scales cover flower buds and young leaves which become covered with sooty mold, buds fail to open.
Pseudococcus adonidum (L.) *(Homoptera, Pseudococcidae)*	Long-tailed mealy bug	With heavy infestations flower stalks and leaves are covered with white fluffy wax; heavy sooty mold infestation follows.
Selenothrips rubrocinctus (Giard) *(Thysanoptera, Thripidae)*	Red banded thrips or Cacao thrips	Feed on undersurface of young leaves particularly; these leaves turn yellow to brown; leaf edges are curled; dark spots of excreta seen, leaf falls.
Sternochetus mangiferae (F.) *(Coleoptera, Curculionidae)*	Mango see weevil	Usually no external signs of damage to fruit; infested fruit may fall prematurely at times; extensive damage to seed.

Table 4. Distribution of Fruit Flies in the English Caribbean Region and Some of their Host Plants

(Revised, Pollard and James, 1982)

Species	Common names	Major Host Plants	Distribution
Anastrepha antunesi	-	Rubiaceae; hogplum; other Plums e.g. Jamaica plum	T&T
A.bahiensis	-	Guava	T&T
A.barnesi	-	Unknown	GUY
A.chiclayae	-	Guava	T&T
A.convoluta	-	Unknown	GUY; T&T
A.dissimilis	-	Unknown	GUY
A.distincta	Pois-doux Fruit Fly	*Inga* spp., Mango	GUY; T&T
A.ethalea	-	Granadilla	T&T
A.fraterculus[2]	South American Fruit fly	Sapodilla; grapefruit orange; coffee; pommerac; mango; guava; hogplum	GUY; T&T
A.leptozona	-	Sapotaceae (Sapodilla family)	T&T
A.ludens[2]	Mexican Fruit Fly	Citrus; mango	BEL
A.mombinpraeoptans[2]	West Indian Fruit Fly	Various plums viz. hogplum; mango; pommerac; guava almond; grapefruit; sour orange; cashew	Throughout the Greater and Lesser[3] Antilles; JA; T&T
A.ocresia	Star-apple Fruit Fly	Sapotaceae viz. star-apple; nase berry (sapodilla)	JA
A.rheediae	-	Hatstand Tree	T&T
A.serpentina[2]	Sapodilla Fruit Fly	Star-apple; Sapodilla mango; sepote; orange	DOM; T&T; BEL
A.striata[2]	Guava Fruit Fly	Guava; mango; various plums	GUY; T&T
A.suspensa[2]	Caribbean Fruit Fly	Almond; guava; pommerac grapefruit; sweet orange; sour orange; hogplum; star-apple; custard apple	JA; Greater Antilles
A.sylvicola	-	Unknown	T&T
Lucoumaphila acidusa	-	Unknown	JA
Toxotrypana curvicauda[2]	Papaya Fruit Fly	Pawpaw	T&T; BAH; Greater/ Lesser Antilles

BAH - Bahamas
BEL - Belize
DOM - Dominica
GUY - Guyana
JA - Jamaica
T&T - Trinidad & Tobago

[2] Species of major importance
[3] Antigua, St. Vincent, Grenada and Barbados are reportedly free of fruit flies.

SOURCE: Stone, 1942; van Wherwin, 1974; Sommeijer, 1975; Laurence, 1976; Bennett et al, 1977; R.M. Bararowski, pers. comm; T. Wilmonson, pers. comm.

Table 5. Some major pest species of citrus and their distribution in the region.

MAJOR PESTS	Common Names	BAH	JA	StK	ANT	MON	GUAD	DOM	MAR	BAR	StL	StV	G'DA	T&T	GUY
HEMIPTERA															
Aleurocanthus woglumi	Citrus Black Fly	+	+							+					+
Aonidiella aurantii	California Red scale	+					+		+	+					
Chrysomphalus aonidum	Purple scale (Florida Red Scale	+	+				+		+	+	+	+			+
Coccus hesperidium	Soft Brown Scale	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Coccus viridia	Soft Green Scale		+	+	+	+	+	+	+	+	+	+	+	+	+
Ceroplastes floridensis	Waxy Scale	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Icerya purchasi	Cottony Cushion Scale	+	+	+	+	+		+		+	+			+	+
Lepidosaphes beckii	Mussel Scale		+	+	+	+	+	+	+	+	+	+	+	+	+
Planococcus citri	Citrus aphid	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Saissetia oleae	Black Scale	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Totoptera	Citrus aphid		+				+		+		+	+	+	+	+
COLEOPTERA															
Diaprepes abbraviatus	Citrus Weevil		+	+	+	+	+	+	+	+	+	+	+		
Diaprepes famelicus	Citrus weevil			+	+	+	+	+	+	+	+	+	+		
Exopthalmus sp.	Fiddler Beetle		+												
Lacnopus sp.			+												
Pachnaeus litus			+												
HYMENOPTERA															
Acromyrmes octospinosus	)Leaf-cutting ant;						+								
Atta cephalotes	)Bachac; Acoushi Ant												+	+	+
Atta laevigata	)														+
Atta sexdens	)														+
Trigona analthea	Black Stingless Bee													+	
Trigona trinidadenis	Black Stingless Bee													+	
DIPTERA	Fruit Flies[1]														
LEPIDOPTERA															
Papilio spp.	Orange Dog		+											+	+
Ciketicus abotti	Bag worm		+												
ACARINA															
Phyllocoptruta oleivora	Citrus Rust Mite		+											+	+

SOURCE: Anon (1972), Hill (1975), Fennah (1937), Weir (1974)

[1] See Table 4

ANT - ANTIGUA
BAR - Barbados
BAH - Bahamas
DOM - Dominica
G'DA - Grenada
GUAD - Guadeloupe
GUY - Guyana
JA - Jamaica
MAR - Martinique
MON - Montserrat
StK - St. Kitts
StL - St. Lucia
StV - St. Vincent
T&T - Trinidad & Tobago

3. CITRUS *Citrus* spp.

There have been a number of investigations of the citrus industry in the Caribbean over the years, (Fennah, 1937b; 1941; 1942; Lister, 1952; Bennett, 1967; Weir, 1974; Avon, 1976). Apart from these there have been numerous publications over the years of the Citrus Research Unit of the University of the West Indies concerning practically all aspects of citrus growing.

Citrus has long been one of the established foreign exchange earners in the regional agricultural sector. In Jamaica, for example, the first commercial citrus groves were reportedly established in 1896 with large scale expansion in the 1930's. In Belize the industry was established early in this century, ca. 1913, and in Trinidad in the early 1930's. In Dominica it appears that the industry began to assume importance nearly 100 years ago, towards the end of the last century; limes have traditionally formed the mainstay of this industry. Trinidad, Belize and Jamaica on the other hand were noted for their grapefruit and then oranges; later, Jamaica also developed its acreages in ortanique (Anon., 1964).

Over the years the fate of citrus has varied in the region suffering set-backs from pests and diseases as well as hurricanes. Price fluctuations on the world markets and cheaper production in other regions have also contributed to the difficulties experienced in the region. In Trinidad there has also been the shift from an agriculture-based economy to one which is energy-based. This has resulted in a general decline in agricultural production, the citrus industry included; however plans are underway to rehabilitate the industry, and already in 1985 production has increased.

There are a number of major pest groups associated with citrus wherever this crop is grown. There are the Hompotera (scale insects, aphids and whiteflies), Cleoptera (weevils), Hymenoptera (ants and bees) and Lepidoptera (moths and butterflies); mites may also be imported pests.

Table 5 lists some of the major pest species in the region. Many of the homopteran insects are very widely distributed regionally and while scale insects, for example, have all been listed as major citrus pests by Hill (1975) they certainly will not be all equally important in every island. These insects are usually found on the leaves, sometimes on the stem and fruit. Feeding on the leaves generally results in leaf-curling and yellowing. Leaf fall and fruit drop may also result from heavy infestation of sooty mold fungus, which could completely cover the leaves and fruits leading to serious loss in photosynthetic activity of the plant. Ants frequently are associated with scale insects, obtaining nutrients from the secreted honey dew. They are themselves pestiferous since they tend to protect the scales from attack by parasites and predators like coccinnelid beetles.

Serious losses generally result from attack by these pests. Citrus Blackfly, for example, was thought to have been responsible for practically wiping out the small backyard citrus industry in Barbados until brought under control by an aphelinid wasp, *Eretmoceros serius*. Other plant-sucking insects are important vectors of disease. The Tropical citrus aphid, *Toxoptera citricidus (kirk)* is the vector of the dreaded Tristeza virus leading to 'quick decline' of plants.

Another major citrus pest in the region, though not very widely distributed, is the leaf-cutting ant (or bachac or acoushi ant). Annual losses in Trinidad exclusive of any yield loss, have been estimated at US$141,300 (Cherrett and Sims, 1968). This latter figure was estimated at 9.5 percent of the annual crop value at that time. In another study Lewis (1975) estimated that at a maximum potential nest density of 36 per hectare *Acromyrmex octospinosus* could defoliate 20 to 25 three-year old citrus trees per annum. Various coleopteran species are also important pests. In Jamaica fiddler beetles are perhaps the most serious pests of citrus. While adults are foliage feeders the larvae are the more serious pest stages. They live in the soil for up to 18 months at times and feed on the roots of the plant. Because of root destruction growth of the plant is affected, and there is a yellowing of leaf veins initially followed by wilting and eventual die-back of

branches (Weir, 1974). According to the author there is also a reduction in leaf and fruit size and sometimes the tree bears a large number of small fruit out of season.

The citrus weevils, *Diaprepes* spp., cause similar damage to the fiddler beetles. These weevils are fairly common in the Windward and Leeward Islands and have been the subject of extensive investigations (Fennah, 1937; 1941; 1942). The adult weevils appear to be fairly polyphagous with a preference for young or newly-matured foliage. Fennah (1942) indicated that, because of this, young trees with a higher proportion of 'palatable foliage' were therefore more susceptible to attack.

Other coleopteran pests have also been identified. They include two leaf-feeding cerambycid species *Leptostylus praemorsus* L. and *Elaphidion mite* Newm. in Dominica and St. Lucia and a weevil *Cryptorrhynachis corticalis* Boh, in St. Vincent (Fennah, 1942). A weevil *Cratasomus punctulatus* Gyll. has been described in Trinidad (Bennett, 1967). The latter damages the leaves, stem and fruit. Adults feed on the leaf edges and on young twigs; they may also chew into the bark and puncture young fruit causing early drop. Eggs are laid below the stem and the hatched larvae bore into the stem tunnelling to distances over 0.5 m in the stem. Tunnels are 0.5 to 1.0 cm in diameter and there may be six or eight running parallel in the stem. Heavily attacked trees may be killed, or if not, invaded by secondary organisms and generally weakened.

Another beetle recently identified in Trinidad is *Glyptoscelis antipennis* (?) (Chrysomelidae). This pest was found to be active in newly-established fields attacking seedlings of 12-18 months. Damage was seen as ring-barking in the lower regions of the plants; leaves were also attacked (C.R. Mahadeo, pers, comm). Fruit flies represent another important pest group of citrus but only of limited distribution in the region (Table 3). *Anastrepha ludens*, the Mexican Fruitfly, is perhaps the most important, being a major pest of citrus in Belize. *A. suspensa* and *A. obligua* (= *A. mombinpraeoptans*) have also been reported for the

Greater Antilles particularly, while Dominica may also occassionally report some damage. Oranges and grapefruits are the host species for fruit flies.

Apart from the major pest species described above (Table 5) there are a number of miscellaneous species which are of minor importance generally or only of local importance. There are various lepudopteran pests attacking both leaves and fruits. The orange dog caterpillar and bagworms are leaf feeders. The most important fruit-attacking pests listed by Fennah (1942) were *Gonodonta incurva* Sepp. in Dominica and St. Lucia attacking oranges and grapefruit and the 'Orange Moth', *Gymnandrosoma* sp., in Dominica. Ripe fruit damaged by *Gonodonta* in Dominica has as many as a dozen punctures each about 0.57 mm in diameter. Another similar lepidoptera pest in Dominica, *Orthreis apta* Wlk, makes holes 0.83 mm in diameter.

In Trinidad there is also an insect attacking grapefruit and orange. Some workers have suggested the stingless bee, *Trigona* sp. is responsible (e.g Hosein, 1969) while others suggest that it is a *Gonodonta* sp. Damage is observed as a single neat hole 3-5 mm in diameter. The nature of the damage in Trinidad suggests something other than a moth and might in fact be well due to *Trigona* sp. or the 'Pegong bee'. One effect of this type of attack is secondary infestation of fungi, beetles and even fruit flies. Weir (1974) reports that in Jamaica *Gonodonta* prefers thin-skinned citrus varieties like ortaniques and temple oranges.

4. GUAVA *Psididiun guajava* L.

Guava has sometimes been regarded as the fruit with greatest potential. A variety of products - jams, jellies, candy (guava cheese), nectar - can all be made and they all appear to have great consumer acceptance. Apart from local cultivars there are those hybrids which are excellent as table fruits.

Mealy bugs and scale insects are some major pests attacking this

crop (Table 2). However, the most important pest species is the Guava fruit fly, *Anastrepha striata* Schin, although other species also infest guava (Table 4). Cock (1985) indicates that *A. bahiensis* Costa Lima, *A. fraterculus* (Weid) and *A. obligua* (Macq.) may frequently be in association with *A. striata* in Trinidad. Like all fruit flies the larva is the pest stage feeding and living inside the fruit. The pulp becomes soft and mushy making the fruit totally unacceptable for fresh consumption or for processing. Infestation may frequently be 100 percent.

5. PAPAYA *Carica papaya* L.

One of the most important pests of papaya generally is the citrus mealy bug, *Planococcus citri* Rissco. This is fairly widespread and though a minor pest of citrus in the Caribbean, it may be of more importance on ornamentals (e.g crotons), cocoa and other crops (Coco, 1985). On Pawpaw, *P. citri* may cause lead shedding, particularly in young plants; buds may also wither.

Another pest of some importance is the papaya fruit fly, *Toxotrypana curvicauda* Gerst. This is a pest of worldwide distribution and is reported to feed exclusively on papaya (Phillips, 1946). Unlike *Anastrepha* spp., *T. cirvicauda* attacks young fruit as well as mature fruit. With attack on young fruit, larvae (as many as 40 per plant) make their way into the seed cavity feeding on the seeds. Premature ripening occurs with fruit drop resulting.

One of the other major constraints to pawpaw production in the Caribbean is Bunchy Top disease. This disease causes death to the growing point and is know to be vectored by *Empoasca papayae* Oman.

Recently though, Haque and Parasram (1973) reported *E. stevensii* to be a vector of this disease in Trinidad. In this country Bunchy Top disease may be extremely severe and the vector must be controlled if pawpaw is to be produced economically.

6. PINEAPPLE *Ananas sativus* Schult

The most serious insect pest attacking pineapples is the Pineapple mealy bug, *Dysmicoccus brevipes* Ckll. Infestations by this pest result in stunted plants and fruit reduction. Similar effects on growth of the plant may also arise as a result of attack by the citrus mealy bug, *Planococcus citri* and *Holopothrips ananasi* Da Costa Lima. The pineapple scale, *Diaspis bromeliae* Kern, apart from affecting growth, also causes dwarf and fibrous fruit (Wyniger, 1962). This same author also makes mention of two weevils causing damaging to the fruits. *Metamasius ritchei* Bs. lays eggs in fruit stalk. On hatching the larvae tunnel into the stalk and the fruit; the larval stages last for 8-10 weeks. The other curculionid pest is *Cholus* sp., the larvae of which also tunnel into the fruit stalks and fruit. Feeding in the stalks could be to the extent that they can no longer support the fruit. Adults also feed on the fruit which bears external feeding marks.

Other minor pests include a lycaenid moth, *Tmolus echion* L., the caterpillar feeding on mature fruit with gumosis resulting; large rotting patches also result from feeding. An anthomyiid fly, *Atherigona* sp., lays eggs in wounds on the fruit. The hatched maggots feed and cause increased damage and rotted areas.

7. AVOCADO *Persea americana* Mill

Avocado originated in Central America and Mexico but is now grown worldwide between 40° south latitude and 40° north latitude. Production in the Caribbean has been classified as "commercially developing" compared with the "commercially developed" industries in the United States or Mexico, for example, (Gustafson, 1976). Avocado is host to a number of pest species. Though these are generally not considered to be major constraints to production it is necessary at times to institute control measures.

Like most tropical fruits, avocados are attacked by a wide range of scale insects. Among the unarmoured or soft scales, *Coccus hesperidium*,

the Brown soft scale, *Saissetia hemispherica*, the Hemispherical scale, *S. oleae*, the Black shield scale, and *Lecanium corni*, the fruit lecanium, are the most important ones. Some armoured or hard scales are also associated with avocados. The Greedy scale, *Hemiberlesoa repax*, the Oleander scale, *Aspidiotus hederae*, the Dictyospermi scale, *Chrysomphalus dictyospermi*, and the California red scale, *Aonidiella auranti* are the ones most commonly encountered. Though these insects are seldom devastating, some trees may be very severely attacked resulting in falling leaves and dried branches.

The leaves are attacked by at least four species of whiteflies, the most prevalent and serious being *Trialeurodes floridensis*. Young nursery plants are particularly susceptible to these insects.

By far the most serious sucking insect which affects avocados in the Caribbean are thrips. These include the Red banded thrips, *Selonothrips rubrocinctus*, the Greenhouse thrips, *Heliothrips haemorrhoidalis*, and the Onion thrips, *Thrips tabacci* with the former being the most damaging. Indirect attack on leaves causes severe bronzing and, in instances of heavy infestation, extensive premature leaf fall occurs. The effect of direct feeding on the fruit, however, is more critical. The skin of the fruit is severely bronzed and may even crack when infestations are heavy. Although this discolouration apparently has little or no effect on the taste of the fruit, the appearance is drastically altered making such fruits unsuitable for sale. Cracking may also allow the entry of secondary pests and pathogens.

Avocados are also subject to chewing insect damage but to a far less degree than sucking insects. A moth, *Xyleutes punctifer*, the larva of which bores into stems of the avocado plant, has become increasingly prevalent in Barbados within the last two years. It was first recorded locally in the early 1930's, but has not been a serious pest until recently.

Older avocado trees are very prone to attacks by termites, *Microcerotermes* sp. and *Nasutitermes aboreus*. The damage usually occurs at root level or internally, resulting in the rapid decline and subsequent death of the plant. The first noticeable symptom of termite attacks in the sudden curling and drying of leaves. Covered tunnels are also seen radiating up the trunk and spreading over all the major branches. IF fruits are present, these may also dry rapidly and fall. Once this stage is reached, corrective treatments have proved rather futile.

Another pest of avocado particularly under wet conditions is the common slug, *Veronicella laevis*. Slugs are capable of defoliating young avocado plants, debarking older ones and killing both types. They are serious pests throughout most of the year, particularly in areas where high rainfall conditions exist.

8. MISCELLANEOUS FRUITS

Apart from those fruits considered above there are other species which have traditionally found their way only into local markets or limited intra-regional trade among CARICOM [1/] members. These fruits may not all have great extra-regional export potential or, if so, perhaps only as "exotic" types in overseas markets like kiwi fruit from New Zealand, for example. Some of these fruit could include:

- Carambola (five finger) - *Averrhoa carambola* L.
- Soursop - *Annona muricata* L.
- Sugarapple - *A. Squamosa* L.
- Sapodilla - *Manilkara zapotilla* (Jacq.) Gilly
- Granadilla - *Passiflora quadrangularis* L.
- Passion fruit - *P. edulis* Sims
- West Indian Cherry of Barbados Cherry - *Malpighia glabra* L. or *M. puniciflora* L.

[1/] Caribbean Common Market

Passion fruit, for example, is a major crop in some countries where it is processed to made an excellent drink. This species should be regarded as one with great potential. In Trinidad both agronomic trials and research in the processing of the fruit are underway, with large scale planting envisaged in the future. Carambola or Five finger is another fruit which, like passion fruit, can be made into an excellent drink.

There have been very few reports published in the Caribbean on insect pests attacking these lesser know fruits. Because of the importance of fruit flies there is a fairly comprehensive listing of their host plants which include some of the fruits mentioned above (Table 3). *Anastrepha leptosona*, *A. ocresia* and *A. serpentina*, for example, are the main species attacking sapotaceous fruits; in fact *A. serpentina* is referred to as the "sapodilla fruit fly" in Trinidad.

Of the annonaceous fruits, soursop (*Annona muricata* L.) is one of the best known and more popular locally, although trees are not as commonly seen as before in some islands. As indicated in Table 1 though, soursops represent the major fruit exported from Grenada to Trinidad. Two major pests of soursop have been reported in the region, the soursop moth, *Cerconota anonella* (Sepp.) and the soursop wasp *Bephrata maculicollis* Com. (Fennah, 1937a; Van Dinther, 1960; Van Doesburg, 1964). Both these pests lay their eggs on young fruit with the larvae then boring into the fruit. In the case of the wasp larvae make their way into the seed where they live and feed. After pupation the adult eats its way back out of the fruit when the major damage is now caused. A number of exit holes are left in the fruit which also allow for secondary infestation leading to further deterioration of the fruit.

Damage may be more severe with the moth, *Ceconota*. In this case larvae tunnel and feed in the pulp of the fruit resulting in blackened, necrotic areas. Usually there is secondary infestation by other insects and pathogenic organisms. The fruit is also malformed and twisted. Around the exit openings the tissue also usually hardens. This pest

seems confined to Trinidad and South America with no reports for the rest of the Caribbean.

Recently in Barbados two pests have been found on soursop which are believed to be new to this country. A purple scale was found in quite large populations. This pest had a serious effect on young fruits particularly, which blackened and died. This pest has not yet been identified. The other pest recorded in 1984 for the first time was a wasp *Bephraatelloides paraguayensis*. Its effect seemed very similar to that of *Bephrata maculicollis*.

The West Indian or Barbados cherry is another fruit that is awaiting greater exploitation. In fact, some countries in Europe have shown interest in this fruit and Barbados has already begun to capitalise on this by shipping cherries to these new markets. However there are various pests which must be effectively controlled in order to realise maximum production.

Sucking insects, particularly scales, pose the greatest threat (Table 2). The Florida Wax Scale, *Ceroplastes floridenis*, the Green Scale, *Coccus viridis* and the Cottonly Cushion Scale, *Icerya purchasi*, are the most common and serious. The relatively small Green Scale is found primarily along leaf veins while the others arrange themselves in rows on the stem. Three *Orthezia* species have also been found on this plant; they produce large amounts of white, waxy secretions. All these scales also produce large quantities of honey dew which attract numerous ants, mainly *Crematogaster* spp. Also associated with honey dew is sooty mold which may cover both the leaves and fruits; badly affected plants may have large portions of their canopy blackened.

Leaf feeding insects may also be important pests of cherry e.g. *Spodoptera* spp. and slugs. Fruit flies also attack the fruit.

9. CONCLUSION

From what has been outlined above there is no doubt that any plans

for increasing fruit production in the region must include strategies for dealing with the variety of insect pest species which are capable of causing significant economic loss in all of the crops considered. However, while insect pests attack is a major constraint to increased fruit production, this is only one of the many.

In an earlier report it was emphasised that the development of an overseas trade in less common tropical fruits necessitated a different approach from that which has developed for the more traditional fruit crops like bananas or citrus (Ravenhill, 1969). This author suggested three factors which must be considered in developing overseas markets for the less common fruits:

- the quality of the fruit produced
- the efficiency and knowledge of the salesman
- the education of the general public to accept the 'exotic' types.

While the latter two come under the general heading of "marketing strategy", the quality of the fruit produced will certainly be mainly affected by pest and diseased.

While it is not too difficult to compile a pest list attacking the various fruit species (Table 2) there is still very little available, however, on the biology and ecology of these pests including the general relationship of pest and crop. To effectively control any pest one must have a knowledge of their life cycles, their different host plants, the nature of damage done. Any effect on yield must also be determined. All this requires a great deal of research. The role, therefore, of entomologists and other crop protection personnel in the region in contributing to increased fruit production is thus clearly marked.

REFERENCES

1. ANON 1964. Citrus. Barclays Bank, D.C.O., England.

2. ____ 1972. Plant Pests of Importance to the Caribbean. FAO/UN, Office for the Caribbean Area, Trinidad and Tobago.

3. ____ 1976. Report of the Working Party Appointed to Investigate the Citrus Industry. Ministry of Finance, Government of Trinidad and Tobago.

4. BENNETT F.D. 1967. Preliminary observations on Cratasomus sp., a curculionid pest of citrus in southern Trinidad with recommendations for future investigations. Unpublished Report Commonwealth Institute of Biological Control, West Indian Station, Trinidad and Tobago.

5. CHERRETT, J.M. and SIMS, B.G. 1968. Some costings for leaf-cutting ant damage in Trinidad. Journal of the Agriculture Society of Trinidad 68: 312-322.

6. COCK, M.J.W. 1985. A Review of Biological Control of Pests in the Commonwealth Caribbean and Bermuda up to 1982. Technical Communication No. 9 of the Commonwealth Institute of Biological Control (CIBC), Unit Kingdom, CAB, 218 pp.

7. FENNAH, R.G. 1937. Lepidopterous pests of the Soursop in Trinidad (1) Cercibita (Stenoma) annonella Sepp. Tropical Agriculture (Trinidad) 14: 175-178

8. _____ 1937. Citrus Pest Investigation. Oviposition and parasitism of Diaprepes in St. Lucia in 1937, including notes on the citrus-growing areas and on recent experimental work. ICTA, Trinidad, Agriculture Advisory Department.

9. _____ 1941. Citrus Pest Investigation. Windward and Leeward Islands. Sixth Progress Report. Report on work during the period January - July 1941. ICTA, Trinidad. Agricultural Advisory Department.

10. _____ 1942. The Citrus Pests Investigation in the Windward and Leeward Islands, B.W.I. 1937-1942. ICTA, Trinidad, Agricultural Advisory Department.

11. GUSTAFSON, D. 9176 World avocado production - 1976. pp. 1-9 in J.W. Sauls, R.L. Phillips, L.K. Jackson (Editors) Proceedings of the First International Tropical Fruit Course, The Avocado. University of Florida, Gainesville.

12. HAQUE, S.Q. and PARASRAM, S. 1973. Empoasca stevensii, a new vector of buncy top disease of papaya. Plant Disease Reporter 57: 412-413.

13. HILL, D. 1975. Agricultural Insect Pests of the tropics and their Control. C.U.P., London 516 pp.

14. HOSEIN, I. 1969. Citrus growing in Trinidad and Tobago. Crop Bulletin 9, Ministry of Agriculture, Lands and Fisheries, Trinidad and Tobago, 8 pp.

15. LAURENCE, G.A. 1976. The fruit fly in Trinidad and Tobago. Journal of the Agricultural Society of Trinidad 76: 101-105.

16. LEWIS, T. 1975. Colony size, density and distribution of the leaf-cutting ant, Acromyrmex octospinosus (Reich) in cultivated fields. Transactions of the Royal Entomological Society Labd. 127 (1): 51-64.

17. LISTER, R.M. 1952. Survey of the Citrus Pests of Trinidad, U.W.I. Library, St. Augustine, Unpublished D.T.A. Report.

18. PHILLIPS, V.T. 1946. The Biology and Identification of Trypetid Larvae (Diptera: Trypetidae). Memoirs of the American Entomological Society 12. 161 pp. + XVI plates.

19. PIMENTEL, D. 1977. The ecological basis of insect pest, pathogen and weed problem. pp. 3-11 in Origins of Pest, Parasite, Disease and Weed Problems. J.W. Cherrett and G.R. Sagar (eds.) Oxford Blackwell Scientific Publications, 413 pp.

20. POLLARD, G.V. 1983. Report on a visit to Grenada, St. Vincent and St. Lucia to investigate the potential pest risks associated with the movement of agricultural produce via the inter-island schooner trade. Report submitted to the Inter-American Institute for Cooperation on Agriculture (IICA), 23 pp.

21. POLLARD, G.V. and JAMES, G. 1982. The distribution of fruit flies in the region with notes on their best plants and methods of control. Extension Newsletter, Vol. 13(3): 1-5.

22. RAVENHILL, D.W. 1969. Trade in less common fruit. pp 51-54 Proceedings of the Conference on Tropical and Sub-tropical fruits; London, Tropical Products Institute.

23. SIMEON, D.T. 1983. Trade of Agricultural Commodities between Trinidad and Grenada. Unpublished Final Year Project Report submitted in part-fulfillment for B.Sc. Agriculture; The University of the West Indies, St. Augustine, Department of Agricultural Economics and Farm Management, 74 pp + appendices.

24. SOMMEIJER, M.J. 1975. Investigations on the occurrence of the West Indian Fly in the Lesser Antilles and Trinidad. FAO Plant Protection Bulletin 23: 185:188.

25. STONE, A. 1942. The first flies of the Genus Anastrepha spp. Washington, D.C., U.S.A. Miscellaneous Publication No. 439, 112 pp.

26. VAN DINTHER, J.B.M. 1960. Insect pests of cultivated plants in Suriname. Landb. Proefst. Bull 76.

27. VAN DOESBURG, P.H. 1964. Two insect pests of soursop in Suriname. Caribbean Agriculture Vol. 3(1): 797-803.

28. VAN WHERWIN, L. 1974. Some fruit flies (Tephritidae) in Jamaica. PANS 20: 11-19.

29. VEVAI, E.J 1971. Know your crop, its pest problems and control - minor tropical fruits. Pesticides 5 (11): 31-54.

30. WEIR, C.C. 1974. Citrus growing in Jamaica. Agricultural Information Service, Ministry Of Agriculture, Jamaica.

31. WYNIGER, R. 1962. Pests of crop in warm climates and their control. Basel, Verlag fur Recht und Gesellschaft Ag. (Acta Tropica Supplementum 7), 555 pp.

DISEASES AS CONSTRAINTS IN THE PRODUCTION OF FRUIT CROPS IN THE CARIBBEAN

by

R.H. PHELPS

CARDI, UWI Campus, St.Augustine,

Trinidad, W.I.

1. BACKGROUND

The Caribbean Region, located as it is in the warm, humid tropics, is a happy hunting ground for plant pathogenic organism. The recent experiences with sugarcane rust and smut, coffee rust, tobacco blue mold, "moko" disease and Black Sigatoka serve to remind us that our balmy trade winds bring more than the roar of surf and the whisper of palm fronds. There seems little doubt that Wellman (19) was correct in remarking at the abundance of plant disease in the tropics, relative to what pertains in temperate zones. Equally significant is his comment that "for every 60 or 65 diseases being given exhaustive attention in the temperate zone, there may be 4 or 5 being given equally intensive study in the tropics". Over the next few days it would be useful to ponder on this statement.

In addressing the task of this review, the need to restrict the number of species became apparent, for there are approximately 100 different species of fruit grown in the region. These were reduced to the seventeen which are more commonly seen in the market place. For convenience they will be considered under four categories, as follows:

- Major plantation crops:
  Banana/Plantain, Citrus, Coconut.

- Minor plantation crops:
  Avocado, Cashew, Guava, Mango, Papaya, Pineapple.

- Miscellaneous tree crops:
  Annonas (Soursop, Sugarapple), Artocarpus

(Breadfruit, Jackfruit), Sapodilla.

- Miscellaneous herbaceous crops:
  Cantaloupe, Granadilla, Passion Fruit, Watermelon.

The history of tropical American plant pathology is replete with records of crop devastations caused by plant diseases. Moko and Panama diseases, cacao witches' broom, black pod, red ring disease, lethal yellowing, tristeza and American leaf spot of coffee are but a few examples of such diseases. Clearly, diseases are important constraining factors of crop production in the region. Their significance as constraints is enhanced when one considers the role they play as agents in the post-harvest destruction of perishables.

As a result of the debilitating or destructive effects of diseases on plants and produce, any examination of their significance in production leads to a consideration of crop loss. Main (5) states that crop losses are the result of changes in structure, organic existence or condition of a crop to an extent that restoration of yield and/or quality is irreversible. Disease loss is now seen as having both biological and social aspects which interplay in a complex manner not fully appreciated by pathologists until recent times (Table 1).

Table 1. Classification of actual crop losses in the economic and social sphere as affected by plant disease[1].

Direct loss[2]		Indirect loss[3]
Primary[4]	Secondary[5]	
Yield	Contamination of sowing and plant material	Farm
Quality	Soilborne diseases	Rural municipality
Costs of control	Weakening of trees by premature defoliation	Exporters
Extra cost of harvesting	Costs of control	Traders (wholesale and retail)
Extra cost of grading		Consumers
Costs of replanting		Government
Loss of income due to less profitable replacement crops		Environment

1. After Zadoka and Schein.

2. Losses sustained by the producer.

3. Losses in social sphere, notwithstanding more or less successful disease control.

4. Losses of yield, quality, or wages as a direct consequence of plant disease appearing before or after harvest.

5. Loss of future production capacity.

It is now well-recognised that the assessment and quantification of crop loss can no longer be the neglected area of plant pathology. We need to refine our methodology in loss estimation in order to devise more cost-effective control procedures.

The demands of society, on the one hand, to maintain environmental purity and of farmers, on the other, to make more efficient use of increasingly expensive inputs, are forcing agricultural scientists to devise integrated systems for the management of crops, with disease management being just one component.

In the Caribbean, there have been only a few studies aimed at quantifying crop or yield loss (1,8). Work in the Dominican Republic on post-harvest losses has sought to develop methodologies for various types of produce (2,6,18). If we are to develop systems for the management of fruit crops in the region, much effort would need to be put into this, so far neglected, area of plant pathology.

2. IMPORTANT PLANT DISEASES OF MAJOR FRUIT CROPS

2.1 BANANA/PLANTAIN - (*Musa* spp.)

The major field diseases are Moko, bacterial head rot, Sigatoka and, more recently, black leaf streak (Table 2,16). The forward march of Moko in Grenada is ominous, for it has the potential to severely threaten the survival of the banana industry in the Windward Islands. At least, it can add substantially to the cost of production in these islands; at worse, there could be a repeat of the Trinidad experience of the early 1960's.

Table 2. Major diseases of banana/plantain.

Disease	Causal Agent
Moko	*Pseudomonas solanacearum*
Bacterial head rot	*Erwinia musae -E chrysanthemi*
Sigatoka	*Mycosphaerella musicola*
Black Sigatoka	*M. fijiensis var difformis*
Black leaf streak	*M. fijiensis*
Burrowing nematode	*Radopholus similis*
Reniform nematode	*Rotylenchulus reniformis*
Anthracnose	*Colletotrichum reniformis*
Crown rot	*C. musae; Fusarium roseum; Verticillium theobromae; Ceratocystis paradoxa; Botryodiplodia theobromae*

The appearance of Black Sigatoka in the region is cause for concern, for it can be expected to widen its distribution as did Sigatoka before it and as black leaf streak is presently doing. The more exacting demands these two diseases make on control procedures will immediately increase the cost of control. If Stover and Dickson (17) are correct in their assumption that *M. fijiensis var difformis* developed from *M. musicola* through mutation and/or sexual recombination, we can expect the appearance of new, more virulent pathovars after unspecified periods of time.

2.2 CITRUS - (*Citrus* spp.)

Several of the citrus diseases are widely distributed in the region, while some are either limited to one or just a few countries or their importance is restricted (Table 3). The Caribbean islands and Central American countries live in the shadow of tristeza, potentially the more devastating disease in the region. The threat is heightened by the fact that the principal rootstock sour orange is the very susceptible. The

problem is compounded by the absence of a proper budwood certification programme, inadequate quarantine services, in a number of countries, and the relative ease of surreptitious entry, especially in the island nations.

Table 3. Major diseases of citrus.

Disease	Causal agent	Limits by host
Sour orange scab	*Elsinoe fawcetti*	Grapefruit; lemon
Melanose	*Diaporthe citri*	Except lime
Greasy spot	*Mycosphaerella citri*	
Foot rot	*Phytophthora parasitica*	More serious on sweet lime, lemon
	P. citrophthora	Sweet orange, grapefruit, rough lemon
Wither tip	*Gloeosporium limetticola*	W. I. Lime
Areolate leaf spot	*Corticium areolatum*	Trinidad, Suriname; sweet & sour orange; grapefruit
Sphaeropsis knot	*Sphaeropsis tumefaciens*	Mainly in Jamaica on lime & rough lemon
Citrus nematode	*Tylenchulus semipenetrans*	Southern Caribbean Islands
Premature fruit drop	*Colletotrichum gloeosporioides*	Belize
Psorosis	Virus	
Tristeza	Virus	Sour orange, grapefruit Guyana and Venezuela
Bird vine	*Phthirusa* sp.	
Blue mold	*Penicillium italicum*	(Higgler trade among
Green mold	*P. digitatum*	countries)

Psorosis is a major contributor to early tree decline. The lack of certification programmes ensures that the disease remains at significant levels. Since leaf symptoms are not expressed under the environmental conditions which exist in most of the region, the disease goes undetected until trees are nearing their prime, a phenomenom that both exacerbates the loss caused by the disease, and makes selection of budwood difficult.

A word needs to be said about exocortis viroid. This disease is not observed frequently in the field because of the widespread use of sour orange rootstock. However, in the event that trifoliate orange, Rangpur lime or the citranges are turned to (for example, because of the danger due to tristeza), exocortis would become an important disease.

With respect to the foliage diseases, we need to refine our fungicidal spray programmes, both in terms of the systems of delivery of the chemicals and their timing. To this end, there is a need for work in epidemiology, assessment of disease loss, delivery systems involving LV and ULV methods and integration with pest control systems. We need considerably more work on the impact of nematodes on tree performance and on the development of cost effective ways to limit their numbers to the levels where performance is maximised. We need to develop more effective control measures for parasitic phanerogams, particularly bird vine, not only on citrus, but mango, avocado and other tree fruit crops.

2.3 COCONUT - (*Cocos nucifera*)

Although the major coconut diseases are relatively few in number (Table 4), their effects are so devastating that the industry is threatened in several countries (3). The difficulties of working with the crop and the complex nature of the diseases have taxed the ingenuity and endurance of the few workers who have dared to take up the challenges posed by coconut pathology. The excellent work done on coconut diseases needs to be continued, so that control procedures can be fully developed.

Table 4. Major diseases of coconut.

Disease	Causal Agent	Location
Bud rot	*Phytophthora palmivora*	Regional
Lethal yellowing	*Mycoplasma*	Greater Antilles, Central America
Cedros wilt/ Hart rot	*Phytomonas* sp.	Surinam, Trinidad
Red ring	*Rhadinaphelenchus cocophilus*	Southern Caribbean

3. IMPORTANT PLANT DISEASES OF MINOR FRUIT CROPS

Bearing in mind the superior quality of the avocado indigenous to the region, it is surprising that there is so little research effort on the crop. The most important disease is root rot (Table 5,7), although, in some instances, acute water damage is the main cause of tree decline. There needs to be an active programme aimed at identifying more resistant root stocks than those presently in use.

The development of control procedures for papaya bunchy top, which would include varietal resistance, should follow the pioneering work that elucidated the cause of the disease and the vector active in the region (15,4). The wide range of cultivars that are available suggests that a concerted attempt at determining which have the broadest resistance to bunchy top, ring spot, cankers, nematodes and anthracnose (Table 5) all of which can cause significant damage, would be productive. Interesting recent findings on the host range of ring spot of papaya indicate the need for more intensive epidemiological studies (13).

TABLE 5. Major diseases of less important fruit crops.

Disease	Causal Agent
Avocado - *Persea americana*	
Root Rot	*Phytophthora cinnamomi*
Algal spot	*Cephaleuros virescens*
Anthracnose	*Colletotrichum gloeosporioides*
Papaya - *Carica papaya*	
Bunchy top	*Mycoplasma*
Anthracnose	*C. gloeosporioides*
Stem and fruit spot	*Corynespora cassiicola*
Bacterial canker	*Erwinia caricae*
Canker	*Phytophthora parasitica*
Ring spot	*Virus*
Reniform nematode	*Rotylenchulus* sp.
Fruit spots (post harvest)	*C. gloeosporioides*
	Phomopsis sp.
	Penicillium sp.
Mango - *Mangifera indica*	
Anthracnose	*C. gloeosporioides*
Algal spot	*Cephaleuros virescens*
Thread blight	*Ceratobasidium stevensii*
Bird vine	*Phthirusa* sp.
Pineapple - *Ananas comosus*	
Heart and Root rot	*Phytophthora parasitica*
Water blister	*Ceratocystis paradoxa*
Root knot	*Meloidogyne* sp.
Reniform nematode	*Rotylenchulus reniformis*
Cashew - *Anacardium occidentale*	
Shoot die back	*Botryosphaeria ribis*
Fruit rot	*Colletotrichum* sp.

Table 5. (Continued)

Disease	Causal Agent
Guava - *Psidium guajava*	
Algal spot	*Cephaleuros virescens*
Fruit rot	*Macrophomina* sp.
Root knot	*Meloidogyne aruenaria*
	M. acrita

In recent times new diseases with destructive potential have appeared (9,10). The effect of nematodes on plant performance is still to be quantified, but the levels of infestation suggest they are significant pathogens (14). The damage caused by the ubiquitous disease, anthracnose, particularly on mango, avocado, papaya as well as the Annonas (Table 5 and 6), highlights its continuing importance as one of the major constraints to the successful cultivation of many of the region's fruit crops. Varietal evaluation for resistance to the disease, similar to that suggested for papaya, would be a useful area of study.

There is not yet a significant literature on the pathology of pineapple, cashew and guava in the region (12) although substantial agronomic work is in progress. This seminar should devote some time to a discussion on mechanisms for better integration among the various disciplines in the development of all fruit crops.

A similar comment, as to the volume of work in plant pathology, can be made with respect to the miscellaneous tree crops listed in Table 6. Although anthracnose is recognised as an important disease of soursop and sugarapple, little investigative work has been done on the disease. Possibly because these are largely "backyard" crops, their pathology has not received much attention and they remain crops with "potential".

4. IMPORTANT PLANT DISEASES OF MISCELLANEOUS TREE CROPS AND HERBACEOUS CROPS

Table 6. Major diseases of miscellaneous tree crops and herbaceous crops.

Species	Disease	Causal Agent
Tree crops		
Annonas - Sugar Apple	Anthracnose	*Colletotrichum gloeosporioides*
- Sour Sop		
Artocarpus sp.	Rosellinia root	*Rosellinia* sp.
Breadfruit	rot	
Jackfruit		
Achras zapota - Sapodilla	Algal spot	*Cephaleuros virescens*
Herbaceous crops		
Citrullus lanatus		
Watermelon	Southern blight	*Sclerotium rolfsii*
	Gummy stem blight	*Didymella bryoniae* (*Mycosphaerella melonis*)
	Blossom end rot	Calcium deficiency
	Seedling wilt	*Rhizoctonia solani*
Cucumis melo		
Cantaloupe	Anthracnose	*Colletotrichum gloeosporioides*
Passifloras - Passion fruit		
- Granadilla	Anthracnose	*C. gloeosporioides*

Of the remaining fruit crops (Table 6), watermelon is the most extensively grown. In Trinidad, southern blight has emerged as an important disease, as a result of the cropping system now in use. Watermelon is rotated with other vegetable crops, many of which are hosts of *Sclerotium rolfsii*. This intensive system has led to a build-up of the pathogen which is noted for its wide host range. Unless studies are initiated to manage such systems, southern blight could become an even more significant disease than it already is.

5. CONCLUSION

In summing up our totals, the conclusion has to be that, except for banana, citrus, coconut and, to a lesser extent, papaya, our knowledge about the pathology of our fruit crops is very limited. This is not surprising. There has been no organised programme on any of the other fruit crops. If the decision is taken to increase fruit production, I suggest we approach the work that must be done from the standpoint of the total management of the crops(s). Our entomologist colleagues moved from biological control to IPM. There are efforts, now, to integrate the disease control. Our challenge is to rope in the other disciplines in order to achieve the goal of effective fruit crop management.

In 1974 the author remarked that "an effective programme of research into the principles governing plant production under the environmental conditions (used in their broadest sense) of our region is vital to the success of our agricultural development" (11). Eleven years later, the comment is equally valid.

LITERATURE CITED

1. Agboade, P.O. 1978. Assessment of losses due to foliar diseases in tomato and peanut. M.Sc. Thesis Univ. of the West Indies Trinidad. 148p.

2. Agudelo, F. 1977. Comments on insect-caused post-harvest crop loss assessment. Reduction of post-harvest food losses in the Caribbean and Central America. Seminar: Document VI-H.

3. Griffith, R. 1976. Wilt diseases of coconuts in the Caribbean. Jour. Agr. Soc., Trinidad and Tobago. 76: 307 - 314.

4. Haque, S.Q. and S. Parasram. 1973. Empoasca stevensi, a new vector of bunchy top disease of papaya. Plant Dis. Reptr. 57: 412 - 413.

5. Main, C.E. 1977. Crop destruction - The raison d'etre of plant pathology. pp. 55 - 78. In: Plant Disease, An advanced treatise. Vol. 1., J.G. Horsfall and E.B. Cowling (eds.) Academic Press. New York 465p.

6. Mansfield, J. 1977. Post-harvest losses of potatoes quantified during the marketing process: From rural assembly to wholesale and retail assembly in Santo Domingo during 1976. Seminar: Document VI-I.

7. Mantell, S.H. and R.H. Phelps. 1974. Avocado decline in Trinidad. Trop. Agr. 51: 417 - 420.

8. Mendoza, G. 1977. Study of post harvest losses of salad tomatoes in the Dominican Republic. Reduction of post harvest food losses in the Caribbean and Central America. Seminar: Document VI - 5.

9. Norse, D. 1973. A stem and fruit disease of papaya in Barbados caused by Corynespora cassiicola. Plant Dis. Reptr. 57: 404 - 6.

10. Persad, G.C. 1978. Etiology of stem canker of Carica papaya. M.Sc. Thesis Univ. of the West Indies. 120p.

11. Phelps, R.H. 1974. Priorities in crop protection research in the Caribbean. pps 303 - 305. In: Crop Protection in the Caribbean Proceedings of a Symposium. C.W.D. Brathwaite, R.H. Phelps and F.D. Bennett (eds.) 319p.

12. Plant disease investigations in the Commonwealth Caribbean 1880-1980. C.W.D. Brathwaite, M. Alcock and R. Soodeen (eds.) IICA Misc. Pub. No. 328.

13. Sanchez, De Luque, C. and G. Martinez Lopez. 1977. Identification of host plants of papaw ring spot virus. Fitopatologia Colombiana 6: 112 - 121.

14. Singh, N.D. 1972. Nematodes infest pigeon pea and papaya trees in Trinidad. Univ. of the West Indies Dep. Agr. Ext. Newsletter 3: 14.

15. Story, G.E. and R. S. Halliwell. 1969. Association of a mycoplasma - like organism with the bunchy top disease of papaya. Phytopathology 59: 1336 - 1337.

16. Stover, R.H. 1980. Sigatoka leaf spots of bananas and plantains. Plant Dis. Reptr. 64: 750 - 756.

17. Stover, R.H. and J.D. Dickson. 1976. Banana leaf spot caused by Mycosphaerella musicola and M. fijiensis var. difformis: a comparison of the first Central American epidemics. FAO Plant Prot. Bull. 24: 36 - 42.

18. Tejada, R. 1977. Summary of study of post-harvest losses of Cassava in the Dominican Republic. Reduction of post-harvest food losses in the Caribbean and Central America. Seminar: Document VI-K.

19. Wellman, F.L. 1972. Tropical American plant disease. The Scarecrow Press Inc. N.J. 989p.

20. Zadocks, J.C. and R.D. Schein. 1979. Epidemiology and plant disease management. Oxford Univ. Press. N.Y. 427p.

PLANT QUARANTINE REQUIREMENTS FOR THE MARKETING OF FRUITS IN THE CARIBBEAN

by

Charles Y. L. Schotman
FAO Regional Plant Protection Officer

1. INTRODUCTION

When we consider the plant quarantine requirements which apply in the different countries in the Caribbean, we see great differences. One country totally prohibits entry of most fruits from any origin, others require a phytosanitary certificate only, and some have detailed regulations imposing plant quarantine restrictions based on potential economic impact.

In the ideal situation, plant quarantine restrictions should only be imposed when absence of the quarantine pest in the importing country is ascertained, the pest is likely to be established if introduced and is liable to attack crops of economic or potential economic importance. The restrictions should interfere as little as possible with trade and traffic and should be carefully examined for their efficiency.

The basic requirements for an efficient functioning of any plant quarantine restriction are:

1. A plant quarantine act or law, forming the legal basis for any plant quarantine restriction and giving the necessary power to the Government for the implementation of these.

2. Plant quarantine regulations, restricting the movement of specific plants, plant parts or goods which may carry pests of plant quarantine importance.

3. Survey and detection programmes, to provide the biological and scientific basis for the plant quarantine restrictions, and detect the introduction of a predetermined quarantine pest early enough to carry out eradicative measures before the pest establishes permanently.

4. Inspection of points of entry, to implement the restrictions specified in the regulations.

1. PLANT QUARANTINE ACT OR LAW

Considering the difficulties observed in some countries in carrying out of the duties of the National Plant Quarantine Services, and in order to provide a basis for harmonizing plant quarantine legislation in the Caribbean, the CPPC organized a Round Table on plant quarantine legislation in the Caribbean held in San Juan, Puerto Rico, 5th August, 1985.

During this meeting, the "Suggested Guidelines for preparing a Plant Quarantine Law" including a model for such a law was presented to the Member Countries of the CPPC. The validity of the principles of this law was recognized by all members, and it was recommended that each country would review its legislation and amend it where necessary.

The model is in conformity with the International Plant Protection Convention (Rome, 1952. Revised 1979) in which, under Article VI, the requirements in relation to imports are specified.

2. PLANT QUARANTINE REGULATIONS

During the Round Table mentioned above, a working group was established with the objective to make specific recommendations on the plant quarantine measures to take by the Caribbean countries against plant pests and diseases of regional quarantine importance. In this way, a set of uniform regulations against the most important pests may be adopted throughout the Caribbean, not only providing a more efficient barrier against entry or spread of dangerous pests, but also facilitating trade.

A list of pests and diseases present in the Caribbean, and those of quarantine importance (present or occurring outside the Caribbean) has been proposed and should be further refined and completed to provide a sound basis for any recommended plant quarantine measures.

3. SURVEY AND DETECTION PROGRAMMES

Survey and detection programmes which are considered of highest priority concern pests of fruits: mango seed weevil, fruit flies, and citrus canker. All these require regional approach and application of uniform and accepted detection methods.

3.1 MANGO SEED WEEVIL

For the mango seed weevil, a proposal for a Regional Survey Programme is in preparation by FAO.

The mango seed weevil, until now reported from St. Lucia and French Antilles, is a pest considered as the most important insect pest in several mango producing countries in Africa and the Pacific, damaging especially late-maturing varieties.

Because the weevil larvae develops within the seed, economically feasible treatment is unavailable. Infested fruits do

not show any visible damage from the outside (unless the adult has emerged) and therefore, the only quarantine measure available to avoid entry or spread of this pest, is to prohibit movement of mango fruits from an infested area into areas still free of the pest.

The drastic method may be very efficient, as the weevil does not spread easily by itself. The Caribbean Plant Protection Commission requested during the Eighth Session, held this year in San Juan, Puerto Rico, that FAO study the possibility of eradicating the pest from the Caribbean.

3.2 FRUIT FLIES

For fruit flies, the Executive Committee of the CPPC already in 1984, recommended the establishment of a region-wide fruit fly detection programme. Most fruit movement is restricted because of the occurrence or suspected occurrence of fruit flies. In other words: fruit may be restricted because of lack of knowledge concerning fruit fly occurrence. Moreover, with the prohibition of EDB used by the USA and other countries, there is no longer an all-round method to eliminate fruit flies from fruits offered for exportation. Therefore, the exact knowledge of the distribution of fruit flies in the Caribbean will lift any unnecessary restriction, and fruit fly free areas may become established.

Standards for the detection and survey programme should be established. A base manual for trapping procedures has already been prepared for use in the Caribbean and is now being reviewed.

For the purpose of the detection programme to be conducted, three trap lure combinations will have to be used.

A. Jackson Traps baited with Trimed lure

This combination is used for the detection of the Mediterranean Fruit Fly and Natal Fruit Fly.

B. Jackson Traps baited with Methy Euginol-que lure-Dibrome. These are used for the detection of *Dacus* spp: Oriental Fruit Fly, Melon Fly and Queensland Fruit Fly.

C. McPhail Traps baited with Torula Yeast. This is best known combination for the detection of *Anastrepha* spp.

The programme further should provide for training of trapping supervisors and operators, identification of specimens, storage of traps, lures and supplies. In addition, an action plan is established for immediate action in case of detection of fruit flies of regional quarantine importance.

•

3.3 CITRUS CANKER

With the recent establishment of a virulent strain of citrus canker in Florida, the citrus producing countries in the Caribbean are concerned with keeping this disease out of their territories. The USDA has stimulated survey programmes in some countries in the region by giving technical assistance. The citrus specialist, Dr. Ary Salybe, urged, during the Eighth Session of the CPPC, that the Caribbean countries take the necessary measures to prevent spread of this disease as well as destructive virus diseases within the Caribbean.

According to this specialist, it is not yet too late to take measures, but any delay may become disastrous to the citrus industry.

4. INSPECTION AT POINTS OF ENTRY

Legislation will be of limited or no value if inspection is not carried out with maximum efficiency.

Plant quarantine inspection is taking place in practically all countries in the Caribbean, but procedures and efficiency vary greatly. Sometimes the powers of the plant quarantine inspectors are not well understood or recognized by other services such as Customs.

Inspection should cover all points of entry including international airports, seaports, mail, border points. Plant quarantine personnel should have the power to inspect any carrier, cargo, package, packing material, luggage or hand luggage to search for objects of quarantine importance.

The most difficult thing may be the decision to inspect a certain consignment or luggage more closely. The situation may be improved by upgrading and harmonizing the inspection procedures.

A first step in this direction will be made at the meeting for plant quarantine specialists in the Caribbean, planned for San Juan, Puerto Rico, 2nd - 6th December, 1985.

The objectives of this meeting will be to established uniform inspection procedures and define the minimum requirements for National Plant Quarantine Services in the Caribbean concerning equipment, facilities, personnel and training, and identifying the limitations of national services in trying to meet these requirements.

ALTERNATIVES TO EDB
SITUATION STUDIES OF QUARANTINE AND PESTS

by

Robert Strong
Animal and Plant Health Inspection Service
U.S. Department of AGriculture
Office in Dominican republic

1. INTRODUCTION

The use of EDB as a fumigant is no longer permitted by regulations of the Environmental Protection Agency (EPA). Hence, foreign agriculture products needing EDB treatment to meet U.S. import requirements, cannot be exported to the U.S.

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) regulated entry of all agricultural products into the U.S. In recognition of the serious consequences of the EPA decision, APHIS has been working with other federal agencies and private sector organizations for several years to develop viable alternatives aimed at eliminating the pest risk posed by fruit formerly treated with EDB.

2. CONVENTIONAL ALTERNATIVES AND METHODOLOGIES

Efforts to find viable treatment alternatives to EDB are concentrated in several areas. (1) Single and double dip hot water treatments for mangoes and papaya respectively, (2) irradiation treatment for papayas. While the double hot water dip treatment has been declared efficacious for the Solo papayas of Hawaii, it is not yet effective for other varieties. Research of the single dip hot water treatment for mangoes is relatively new and is not yet conclusive. Irradiation treatment is currently being researched and is not

considered a viable alternative in the near future. All of the above methods are aimed at eliminating the pest risk by killing fruit flies infesting host materials. The extent of the killing process determined the efficacy of the treatment. With respect to irradiation, however, there are also problems with consumer acceptance and marketability of products irradiate.

3. NON-CONVENTIONAL ALTERNATIVES

Under the Caribbean Basin Initiative (CBI), APHIS is assisting CBI countries in developing programs to detect, control and eradicate economically important pests of concern to the United States. These activities are aimed at reducing and/or eliminating pest risk at source of origin in order to remove barriers to exporting to U.S.

3.1 FRUIT FLY TRAPPING

Survey and detection of major fruit flies of exportable products are essential to determine the pest risk associated with certain host materials from certain countries. Currently, data used in making pest risk analysis are collected from literature which in many cases, from pest interception date. Basically, the pest risk analysis process does not often include data deriving from survey and detection efforts within the exporting countries. Fruit fly trapping programs provide a method for determining presence of major fruit flies of concern to U.S. in countries desiring to export fruit fly host materials. Trapping data can be evaluated and conceivably provide a basis for changing entry requirements for certain products.

In areas where major fruit flies are not detected, consideration may be given to declaring such areas "fruit fly free zones" for export purposes. This concept, however, can only be applied where effective plant quarantine and survey/detection programs are established and maintained. The integration of these

systems provides security and early detection to the designated fruit/fly zone area.

3.2 CERTIFICATION OF EXPORT ZONES

For several year, APHIS has participated with foreign government/exporter groups in establishing pest management programs aimed at creation of pest free zones for export purposes. Pest management practices are maintained throughout the year by exporters along with established survey and detection programs conducted by the exporting country and/or APHIS personnel. This cooperative effort among private and participating government plant protection units led to the establishment of "certified areas or export zones." Under this concept, APHIS' concerns and pest risk problems have been addressed through combined activities of pest management, survey and detection and safeguards. As a result, products exported from certified areas receive minimal inspection at U.S. ports of entry.

3.3 PLANT QUARANTINE

Plant quarantine is essential to prevention of pest introduction and/or spread. Hence, exporting countries are advised to establish new plant quarantine programs or improve existing systems to assure effective present introduction and spread of exotic pests. Historically, in the Caribbean Basin, plant quarantine has not received the attention and/or resources to provide for an effective network to exclude exotic pests from the area. Accordingly, APHIS is assisting CBI countries to establish plant quarantine systems as an integral part of new survey/detection (fruit-fly trapping) programs that are implemented. Conceivably, implementation of effective plant protection and quarantine programs will result in increased capability by CBI countries for exporting fruit fly host products to the U.S. without increasing the risk of pest introduction.

4. SITUATION REPORTS

Below are situation reports on Citruc Canker control in Florida, Africanized Honey Bee in California, Oriental Fruit Fly and Melon Fruit Fly.

Survey for Citrus Canker. Situation Report #141 September 16, 1985

Citrus canker has been confirmed on the Hancock Ranch Grove, DeSoto county. This is the first detection in this county and the first in a grove. The grove which is approximately 6 miles southeast of Arcadia on Highway 31 consists of 300 acres with 43,157 resets planted. It is isolated from other groves and will not necessitate the defoliation of plants around the area. Destruction of the plants will begin on September 16.

All general surveys are progressing well considering the added workload of destroying exposed resets from Adams' Field Grown Nursery. Additional personnel are being hired and trained to augment the workforce. Requests for fresh fruit harvesting permits are increasing with grove owners planning for harvesting season.

Field stations are continuing to contact grove owners, take inventories, survey, and destroy exposed resets. Destruction of exposed resets sold since June 15, 1985, is nearing completion throughout the State. Work is continuing on contacting, inventorying, and surveying the August 30, 1983, trees.

Seven hundred Citrus Canker Project personnel and the Division of Plant Industry (DPI), Florida Department of Agriculture and Consumer Services, inspectors viewed an infestation of citrus canker in the field. Strict control was maintained and decontamination procedures intensified. Many favorable comments have been received, with the inspectors feeling that it was a most valuable training experience.

It is planned to have district DPI nursery inspectors work with the canker nursery surveyors in order to provide additional training and to evaluate and improve survey techniques.

Control

Destruction and initial defoliation have been completed at Ward"'s Fox Lake Nursery. All field plants at Adams' Field Grown Nursery have been destroyed. Tree destruction in the greenhouses, decontamination of the greenhouses, and defoliation of grove trees which immediately surround the nursery remain to to be completed.

Regulatory

The regulatory staff attended a meeting of Citrus Mutual in Lakeland. Questions were answered concerning the new canker finds and suspect finds.

The first fresh fruit of the new season moved through Golden Gem Packinghouse. The fruit came from the southern part of the State.

As of September 6, 1985, all movement of citrus plants within Florida and from Florida to other States has been prohibited. Calamondins are also included in the ban. Letters are being sent to all affected nurseries.

Report #140. September 9, 1985

Citrus Canker was confirmed in Ward's Fox Lake Nursery, Avon Park (Highlands County), by a second positive sample diagnosed on August 30. No trees have left this nursery, since the seedlings were to be used only on Ward's property. The 9,741 trees in the ½ acre nursery were destroyed on September 4. Investigation into the source and date of introduction of citrus canker is continuing.

Residental, nursery, delimiting, and reset survey, and destruction of exposed Hillsborough dooryard trees are continuing with no major disruption. The two new positive nursery finds are reducing the amount of general grove survey being completed. Top priority is still on inventory, survey, and destruction of exposed resets from Adams' Nursery in groves. Until the hiring and training of additional personnel are accomplished, the completion of grove surveys will be deferred.

Distribution of exposed resets sold from Adams' nursery after June 15, 1985, was fairly even in the northern three Citrus Canker Work Units. Winter Haven Work Unit groves received 34.7 percent of the total number of resets, Sebring Work Unit received 30.9 percent, Ft. Pierce 30.2 percent, LaBelle 4.04 percent, and Ft. Lauderdale .05 percent.

Work units that received a large number of resets are in the process of contacting the grove owners, inventorying, surveying, and destroying the exposed resets. Early completion of the tree destruction is dependent upon the number of grove owners who waive the 10-day period they are entitled to wait before either beginning destruction by or requesting a court review.

Control

The destruction is nearing completion in the southern half of Adams' Field Grove Nursery. Destruction of trees in the northern half may take longer due to greenhouses in that portion of the nursery.

Regulatory

The Regulatory staff attended Packinghouse Day at the Lake Alfred Experiment Station. A total of about 270 people from the packing and processing industry attended the meeting. The new compliance agreements and fruit harvesting procedures were discussed. After the morning presentation, a question-and-answer session was conducted by the Regulatory staff. About 100 people came to ask questions and offer

suggestions. A handout which detailed the regulations and disinfection procedures was distributed. About 200 copies were given out.

The Regulatory staff attended a meeting with the Gift Fruit Shippers Association. Pete Knight from the Florida Department of AGriculture and Consumer Services, Fruit and Vegetable Inspection Division, detailed the new inspection procedures. The citrus canker regulations were explained, and suggestions were taken for consideration.

A meeting was held with the Ft. Pierce port inspector. The post personnel will provide assistance in putting up citrus canker signs and provide information to airlines.

General

Project officials placed an immediate ban on further movement of citrus plants from Florida nurseries for an indefinite period. In addition, the action also prohibits any movement of citrus budwood through the State. The action is necessary to permit adequate surveys during the period of most favorable environmental conditions.

Survey for Africanized Honey Bee Situation Report #28. September 13, 1985

I. FERAL NEST SURVEY	Total
A. Residental/Structural Inspections	
Sections (Sq. Mi.) Completed	708
Inspections Made	2,350
Feral Nests Found	35
Feral Nests Sampled	10
Feral Nests Destroyed	10
B. Public Call-ins	
Calls Received at Lost Hills	520
Calls Meeting Response Criteria	361

Feral Nests Found	309
Feral Nests Sampled	273
Feral Nests Destroyed	143
Feral Nests Left in Residential Walls	130

II. TRAP HIVES

A.	Trap Hives Deployed	683
B.	Trap Hives Serviced	1,790
C.	Swarms Trapped	2

III. APIARY SAMPLING

A.	Apiaries Sampled	181
B.	Colonies Sampled	15,855

IV. LAB REPORT

A.	Apiary Testing		
	1.	Step 1 Test Passed	6,759
	2.	Step 2 Test Passed	1,039
	3.	Step 2 Test Forwarded	334
	4.	Confirmed Africanized Colonies	4
	5.	Total	8,196
B.	Feral Swarm Nest Testing		
	1.	Step 1 Passed	292
	2.	Step 2 Test Passed	117
	3.	Step 2 Test Forwarded	87
	4.	Confirmed Africanized Swarm Nest	2
	5.	Total	498

V. REGULATORY ACTIVITIES

A.	Apiaries Under Hold Order	214
B.	Compliance Agreements Issued	32

C.	Verbal Warnings Issued	8
D.	Notices of Noncompliance Issued	0
E.	Quarantine Violations	1
F.	Apiaries Verified	430
G.	Apiaries Cleared for Honey Super Release	15
H.	Apiaries Released	0
I.	Cert. of Quarantine Compliance	4

Comments: One feral swarm was taken from a bait hive set on the ground within the quarantine area.

Survey for Oriental Fruit Fly. Situation Report #1 Sepetember 13, 1985

Seventeen mature adult males have been detected from the Long Beach, California, area (Los Angeles Country).

They were confirmed on September 10 and 13, 1985. Thirty-none Jackson and 39 McPhail traps have been installed in the core area around the three locations which are about 1/2 mile apart. Two hundred and eight Jackson traps and 48 McPhail traps have been installed outside the core area.

Male annihilation treatments were initiated on Friday, September 13, 1985. Parallel State and Federal regulations are being drafted.

Extensive fruit cutting is in progress, but no larvae have been found.

Survey for Melon Fruit Fly. Situation Report #1. September 13, 1985

On September 11, 1985, a single, fresh, mature male melon fruit fly was captures in a Jackson trap in a peach tree in San Diego Country, California. The location was 9001 Bovina in Mira Mesa, which is approximately 10 miles north of San Diego.

METHODS AND TECHNIQUES FOR ALLEVIATING POSTHARVEST PROBLEMS IN FRUIT MARKETING

by

Ena C. Harvey

Food Technologist

Caribbean Industrial Research Institute

St. Augusting, Trinidad and Tobago

1. INTRODUCTION

International trade in fresh tropical fruit has expanded steadily over the last two decases. Fruits such as the avocado, mango and papaya have become important earners of foreign exchange for countries like Israel, Brazil, Kenya, Ivory Coast and the Philippines. In the Caribbean Regional, several countries including Jamaica, Barbados, Haiti, St. Lucia, Martinique and Guadeloupe have been increasing exports of fruits to both regional and extraregional markets (Farm News, 1985; Courier, 1985). Several factors have contributed to this steady expansion of trade. They include:

- Increase consumer familiarity with tropical products due to more extensive overseas travel, promotional marketing campaigns and immigrant populations initiating a market for these products.

- Higher standards of living creating a higher demand for 'exotic' fruit.

- Improved methods of air and marine transport of perishables.

- Improved postharvest technologies for prolonging shelf life.

- Capitalization on export opportunities made possible through the Caribbean Basin Initiative and other export promotion campaigns.

- A more systematic and commercial approach to production and marketing of these products.

Export markets are highly discriminating, competitive and very exacting with respect to fruit quality (shape, size and colour), packaging, presentation and regulation of consignments. Significant penetration of export markets and the maintenance of satisfactory trading partnerships cane only be achieved when there is full integration with respect to technical, infrastructural and operation requirements and maximization of product quality at every stage of the marketing channel.

Tropical fruits for export have special postharvest handling requirements mainly because of their extremely high perishability and the long distances between the producing countries and their major export markets. The quality of exported fruit therefore depends on the degree to which its shelf life can be extended through manipulation of its physiology, the level of protection offered against mechanical injury and attack by pests and diseases and on the efficiency of the transport system.

Each handling operation results in a finite and measurable loss in quality and quantity. Careful management of the product within the marketing chain is therefore critical. This paper focuses on the methods and techniques which can be applied at various stages in the production-marketing system, to alleviate postharvest problems in fruit marketing.

2. FIELD OPERATIONS

2.1 PRE-HARVEST

The selection of suitable and appropriate fruit cultivars is essential to the export industry. This is particularly important in terms of the investment required for fruit trees and the long

gestation period that exists between planting and receipt of revenue from exports.

Particular attention should be given to characteristics such as yield, concentration of fruit set, seasonality, climatic adaptability and disease/pest resistance. Factors such as shipping, storage and shelf life characteristics and market qualities such as size, shape, colour and flavour also play an essential role in production of produce suitable for export marketing. For example, requirements for mangoes in the European market include excellent cosmetic appeal, high sugar content, delicate fragrance, firm fibreless flesh, low terpene levels and a small stone.

At present, the American red and violet/yellow cultivars like Haden, Irwin, Tommy Atkins and Ruby meet these requirements and command a premium on the market. The Julie is also considered as very attractive with good market potential (Courier, 1985). As far as size is concerned, the European consumer tends to want a mango weighing 250-400g and the distributor who sells the fruit by the unit prefers smaller ones (250g) in the winter when prices are usually high and bigger ones (400g) in the summer when prices are lower.

West Indian avocado varieties such as Lula, Booth, and Pollock have a shorter shelf life and are more susceptible to damage than sub-tropical cultivars like Fuerte and Hass which currently account for 90% of the supply on European Economic Community (EEC) markets (La Rosa, 1985). In the case of papaya, the demand is for small fruit weighting between 250-400g from selected strains of the Solo type.

2.2 HARVESTING

The degree of maturity of the product at the time of harvest is directly related to transit and marketing life and quality.

Harvesting produce at the correct stage of maturity ensures:

- Fitness for consumption.
- Suitability for storage and transport.
- Ability to ripen normally.
- Conformity with legislation (where applicable).

For most commodities, maturity indices have been defined; for example, soluble solids content and skin colour in papaya, oil content in avocado and skin colour and fruit shape in mango.

Commodities suffer many types of handling abuses at harvest. These include abrasion, compression and impact bruising, cuts, breakage and heat stress. Methods and techniques available for minimizing these injuries include:

2.2.1 Careful Field Supervision - This is the most critical factor in protecting fruits from injury. Physical injuries can result from improper picking procedures, excessive dropping of fruit into containers, overfilling, hitting picking containers against tree limbs and ladders and careless transfer into larger containers.

2.2.2 Use of Appropriate Field Containers - In the Caribbean, woven baskets, polypropylene sacks and wooden crates are commonly used in domestic marketing and in intra-regional trade. These containers have the advantages of high capacity and economy; baskets hold 25-50 kg and cost EC$10-$15.00, sacks have a capacity of 12-30 kg and cost between EC$1.00 and $1.50, and wooden crates made from broken pallets and costing EC$10-$15. have a capacity of 150-325 kg (Simeon, 1983). They however have poor compression and wet-strength characteristics and frequent recycling (as much

as 5 trips for baskets (Simeon, 1983) often exposes produce to the risk of spoilage and infection. Possible improvements can be achieved by using supplemental packaging materials such as liners, wraps, trays, cups, shims and pads; by stacking containers within their design limits; and by proper venting of containers.

Moulded, vented stackable plastic crates and corrugated carton offer advantages over these traditional types of containers with respect to the degree of protection offered, ease of cleaning, and utilization of space. The IICA Office in Grenada recently designed and tested a crate for transport of agricultural produce. Large-scale production of these creates is to begin in the near future (Simeon, 1983).

2.2.3 Use of Harvesting Aids - Picking poles, picking bags and aprons facilitate more careful harvesting of fruits. A picking pole currently in use for harvesting papayas in Hawaii consists of a long-handled suction cup which is positioned over the stylar end of the fruit. A twist of the handle breaks the fruit's pedicel and the picker catches the fruit if it falls from the suction cup (Sommer, 1985). In Thailand, a new papaya picking implement has been developed especially for small orchards on hilly terrain. The implement consists of a pole and a bag, the top half of which is made of canvas and the bottom half of nylon mesh. The mesh enables the picker to see the fruit and accurately position the narrow, flat blade, specially designed for easy manoeuverability and minimum damage to the fruit peel, against the fruit stem (ASEAN, 1981).

Picking bags and aprons are also useful. An apron, recently developed at CARDI (Chandler, 1985), has two compartments which allow for in-field grading. Zippers at the base facilitate emptying and minimize bruising. Bottom dump

bags, used extensively for harvesting soft stone fruit in California can also be used.

2.2.4 Temperature Management of Produce - Effective cooling and temperature management are essential for successful marketing. The rapid removal of field heat (or precooling) is one of the most important pre-transit treatments for fruits. Several cooling methods and variations are available and the choice of a cooling method depends on product adaptability, rate of cooling desired, potential for rewarming, type of packaging and package handling system and cost. Table 1 describes the main cooling methods available and lists the commodities for which each method is suitable.

Under Caribbean conditions, room cooling, forced-air cooling and evaporative cooling seem to be best suited to the postharvest handling systems currently inuse, in terms of available infrastructure. degree of quality control required and prevailing climatic conditions. Evaporative cooling techniques are very energy efficient and economical and they offer significant benefits for precooling in the less humid islands such as Barbados and Antigua where low wet-bulb temperatures would facilitate cooling to low temperature.

Temperature management does not automatically imply the need for refrigeration. In cases where precooling facilities may not be near or available, the following practices are recommended:

TABLE 1. Cooling methods and suitable commodities

Cooling method*	Commodities cooled	Comments
Room cooling	All commodities	Too slow for many perisable commodities. Cooling rates vary extensively within loads, pallets, and containers.
Forced-air cooling (pressure cooling)	Fruits, berries, fruit-type vegetables, tubers cut flowers, cauliflower	Much faster than room cooling; cooling cooling rates very uniform if properly used. Container venting and stacking requirements are critical to effective cooling.
Hydrocooling	Stems, leafy vegetables some fruits and fruit-type vegetables	Very fast cooling; uniform cooling in bulk if properly used, but may vary extensively inn packed shipping containers' daily cleaning and sanitation measures essential; product must tolerate wetting; water-tolerant shipping containers are essential.
Package-icing	Roots, stems, some flower-type vegetables, green onions, brussels sprouts	Fast cooling; limited to commodities that can tolerate water-ice contact; water-tolerant shipping containers are essential.
Vacuum cooling	Leafy vegetables; some stem and flower-type vegetables.	Commodities must have a favourable surface-to-mass ratio for effective cooling. Causes about 1% weight loss for each 6°C cooled. A procedure that adds water during cooling prevents this weight loss but equipment is more expensive, and water-tolerant shipping containers are needed.

Table 1 (continued)

Cooling method*	Commodities cooled	Comments
Transit Cooling:		
Mechanical refrigeration	All commodities	Cooling in most available equipment is too slow and variable; generally not effective.
Top-icing and channel-icing	Some roots, stems, leafy vegetables, cantalopes	Slow and irregular, top-ice weight reduces net pay load, water-tolerant shipping containers needed.

* For these methods to be effective, cold-storage rooms are needed to hold the commodity after cooling.

- Harvesting of fruits in the early morning or during the night. This reduces the field heat and also cuts down on subsequent cooling costs. (Thompson, 1985).

- Shading of harvested fruits under natural shade such as trees or vines or artificial fixed or portable shade such as sheds or tarpaulin.

- Covering of transported loads with light-coloured (silver or white tarpaulin. The tarpaulin should be supported so as to maintain an air space over the load. Wetting of the tarpaulin will further reduce warming by providing an evaporative cooling surface.

2.2.5 Protection during field transport - Several simple yet effective techniques are availiable for reduction of injuries incurred during transport from the field. Some of these include:

- Grading of access roads to eliminate ruts, potholes, bumps.

- Restriction of transport speeds to levels that will avoid free movement of produce.

- Reduction of tyre pressure on vehicles to reduce shock absorbance by produce.

- Use of air suspension systems on transport equipment. Surface marking injury levels have been found to be be proportional to acceleration levels of containers carrying produce. Studies carried out on truck/trailer units showed that as much as 50% reduction in acceleration level of containers was possible with the installation of air suspension systems on all axles of truck and trailer (Mitchell, 1984).

- Inspection of container surfaces to determine the potential for injury to produce.

3. PRODUCT PREPARATION FOR EXPORT MARKET

Harvested fruits undergo a number of treatments prior to shipment. These may include grading; sorting; application of chemical treatments to control pests, diseases, ripening and senescence; packaging and storage. Depending on the level of technology and operating skills required, these operations may be carried out in a centralized facility such as packinghouse or in a decentralized system.

3.1 PEST AND DISEASE CONTROL

An integrated preventive approach should be employed in the strategy for postharvest control of pests and diseases. This includes field control of pathogens, especially those which give rise to latent infections, reduction of inoculum levels by strict attention to sanitation of field containers, packinghouse equipment, water for precooling and dumping; and prompt separation of decayed and sound produce. The type of postharvest handling the produce receives and the physiological and physical condition of the produce, also have a great effect on the losses incurred. Fruits with high vitality exhibit considerable resistance to fungal attack compared to stressed or senescent fruit which are often disease-prone. Handling procedures should therefore emphasize methods which maintain product quality and which, directly or indirectly limit the potential for invasion and development of pathogens.

3.1.1 Chemical Treatments for Disease Control

A wide range of chemicals is registered for postharvest treatments to prevent crop decay caused by fungi, bacteria and yeasts (see appendix). The use of fungicide-impregnated pads and wraps may have some potential for use in shipped fruit

from the Caribbean. Biphenyl pads have been used successfully in shipments of citrus from the USA to Holland and storage decay of pome fruits was successfully controlled with the use of iodine-potassium iodide wrappers (Sumbali and Mehrotra, 1983).

The future of chemical treatments in use cannot be regarded as secure because of (i) the emergence of tolerant strains of *Botrytis* and *Pencillium*; (ii) requirements for establishment of residue tolerances for postharvest chemical treatments and (iii) standardization of practices for the application of chemicals to crops (Edney, 1985; Commes and Holett, 1985). The latter two factors have important implications for the export of commodities from the Caribbean to Europe and the United States.

3.1.2 Treatment for Insect Control

The recent ban imposed on the use of Ethylene Dibromide (EDB) as a fumigant for quarantine treatments for fruit flies has led to investigations on a number of alternative treatments. In Hawaii, a double-dip hot water treatment is being used as an alternative to the combination hot water/EDB treatment previously used. The first dip at 42°C for 40 minutes, kills eggs buried 2-5mm below the fruit skin. It is followed by a 20-minute dip at 49°C (Sommer, 1985). In Haiti, a number of hot water treatments are currently being evaluated for treatment of exported mangoes against West Indian fruit fly (USAID, 1985).

The use of gamma radiation for insect control has yet to be approved. While results on insect sterilization appear promising, a number of issues still beed to be resolved. These include detrimental effects from dose levels below 1KGy; logistics of application of the treatment; economics of the treatment and social and public reaction to consumption of irradiated foods (CAST, 1984; Sherman, 1985).

3.2 GRADING/SORTING

Manual sizing is commonly practised for many tropical fruits. Training and supervision of workers in careful handling of fruits is important. In merchanized sorting systems, it is self-defeating to have a sorting line that causes fruit injury. Thus, the delivery systems, the sorting belt and distribution system must be designed to avoid injuries. Fruits should flow along belts one layer deep, the height and number of drops should be minimized, corners should be smooth and well-rounded and fruit flow rates should be controlled to avoid unnecessary accumulation.

3.3 TREATMENTS FOR DELAYING RIPENING AND SENESCENCE

Integrated methods for delaying ripening and senescence should be adopted. Physical injuries, decay organisms and other stresses can cause increased ethylene production in fruits and careful handling and temperature management of the commodities are critical.

Developments in the use of treatments for delaying ripening include the use of various coatings and dips. Tal Pro-Long and Pick 'N' Save are two coatings which utilize the concept of production of a modified micro-atmosphere around the product. They are both transparent and tasteless sugar-based films which are non-toxic and edible. They reportedly slow down respiration and metabolism and retard ripening by restricting the rate at which gases and water vapour move across the fruit skin (International New Product Newsletter, 1985).

Calcium compounds have also been used. Singh and Chauhan (1981) showed that treatment of guavas with calcium nitrate solution delayed the onset of senescence and maintained edible quality in the fruit for over 6 days. Recent studies in Australia

with mangoes and avocados have shown the infiltration of calcium chloride into freshly harvested fruits delays ripening. The time taken for mangoes and avocados to ripen was increased by about 40% (Scott, 1984).

3.4 PACKAGING AND PACKING

Packages for horticultural produce should provide:

- Protection against handling abuse in marketing and distribution channels.

- Accommodation for temperature management of the produce during pre-cooling, storage and ripening.

- Wet-strength and compressive-strength characteristics compatible with in-package cooling operations, high volume packaging systems and handling methods in distribution channels.

- Consumer appeal, if used for display and promotion.

There are three important requirements in packing fruits to protect against handling abuse:

3.4.1 Immobilization within the container. This can be achieved by wrapping or place packing of sized fruits using trays and pads, volume-fill packing and tight-fill packing with controlled vibration settling.

3.4.2 Protection from compression. Compression strength and resistance to moisture are two of the most important characteristics of packages for export. In a failed container, the produce assumes the stacking stresses and compression bruising results. The use of moisture resistant materials and supplemental reinforcements such as cross-wise

dividers, end panel inserts or special corner posts can increase strength.

3.4.3 Cushioning against impacts. Cushioning pads can be used to absorb the shock of impacts and so reduce bruising. Unitized handling on pallets also reduces rehandling of packaged products and has aided in reducing impact bruising (Mitchell, 1985)

The handling of fruits in a wide assortment of package size may lead to marketing problems especially for exports to European markets. Recommendations made by the (Organization for Economic Cooperation and Development (OECD) and Unitization Committee of the United Fresh Fruit and Vegetable Association (UCUFFVA) on the metrication and standardization of package sizes should be noted by Caribbean exporters. Metric size packages that should be considered for export are; 400 x 300mm, 500 x 300mm, 500 x 400mm, 600 x 400mm and 600 x 500mm (outside base dimensions). These package sizes are compatible with the metric pallet which is 1000 x 1200mm.

4. TRANSPORT

Recommended methods and techniques for proper handling of tropical fruits during transit deal mainly with the choice of carrier, the use of efficient loading patterns and management of temperature, relative humidity and levels of gases such as CO_2, O_2, ethylene and other volatiles in the product environment.

4.1 CARRIER

Air freight and refrigerated marine transport are the two choices open to Caribbean exporters for shipment of tropical fruits. In the intra-regional trade of fruit in the Caribbean, the poor condition of fruits transported by sea in small schooners at

ambient conditions provides ample evidence of the unsuitability of this system for export marketing. Even for refrigerated marine transport, however, the length of the journey by sea is often close to the limits of shelf life for many tropical fruits (see Table 2). The high cost and limited capacity of air shipment, on the other hand, outweigh the advantages of the relatively shorter transit time, and indicators are that appropriate sea transport techniques will have to be developed for the export of tropical fruits (Proctor, 1985). One development in this regard is the reverse-flow or bottom air delivery circulation system which is becoming very popular with ocean carriers because of its improved performance with fresh fruits and vegetables (Nicholas, 1985).

4.2 LOADING AND ENVIRONMENTAL CONTROL

Loading patterns play an important role in the successful transportation and delivery of export shipments of fresh fruits. Uniform temperatures control and maximum utilization of available refrigeration are highly dependent on the loading pattern and good air circulation throughout the load.

A good loading pattern should:

- Provide a network of channels to allow uniform air circulation throughtout the load such that fruit pulp temperatures are quickly reduced to optimum levels and are maintained at ± 0.5°C throughout the journey. Stacking patterns should be made compatible with the ship's refrigerated airflow system.

- Be sufficiently stable to remain intact during transit to help prevent container failure or commodity damage.

- Utilize the inherent strength of the package.

TABLE 2. Normal holding temperatures for tropical fruit and expected life.

	Temperature in °C	Duration
Avocado		
Fuerte and Hass		
(Unripe)	5.5 - 8	3 to 4 weeks
(Ripe)	2 - 5	1 to 2 weeks
Guava	8 - 10	2 to 3 weeks
Kiwifruit	0.5 - 0	2 to 3 months
Limes	9 - 10	1 to 2 months
Lychees	3 - 4	0.5 to 1 month
Mango	7 - 14	1 to 4 weeks
Papaya (turning)	7	1 to 3 weeks
Passionfruit	7 - 10	1 to 3 weeks

SOURCE: Proctor, F.J. Postharvest handling of tropical fruit for export. The Courier, No. 92, July-August 1985.

Optimum air recirculation and air exchange rates should be defined to keep ethylene levels to a minimum (threshold levels for ethylene could be as low as 10 parts per billion (Sherman, 1985), to avoid excessive carbon dioxide build-up, to maintain transit temperature and to minimize moisture loss.

The transportation of more than one commodity type in a shipment must take into consideration the compatibility of the products with respect to temperature, atmospheric modification, relative humidity, biologically harmful volatiles, the tendency for absorption of objectionable odours and difficulties in loading different sizes and shapes of container. Compatibility tables complied by Lipton and Harvey (1977) list tropical fruits in groups with temperature requirements of 13-18°C and 85-95% relative humidity (Table 3). In shipments that consist of more than one size or type of package, special bracing or dunnage should be installed to isolate packages that might be damaged from adjacent stacks of containers.

TABLE 3. Recommended compatibility regimes and transit conditions for fruits.

Compatibility tables[1]

Commodities with special requirements[2]

Avocados

Ripening would be rapid at 55° to 65° (13° to 18°C); chilling injury may occur below 50°F (10°C).

Citrus Fruits

Biphenyl, which is used as a fungicide on citrus fruits, may impart off odors to other commodities.

Lemons - For holding 1 month or less, 32° to 55°F (0° to 13°C) is acceptable; for longer periods, 50° to 55°F (10° to 13°C) is necessary.

Limes - Do not hold below 45°F (7°C) longer than about 2 weeks.

Oranges and Tangerines - Compatibility depends on source. Florida-grown or Texas-grown oranges are shipped at 32° to 40°F (0° to 4.5°C), but California-grown and Arizona-grown ones are shipped at 40° to 44°F (4.5° to 7°C).

Grapes

Compatible with other crops only if the grapes are not fumigated with sulfur dioxide (SO_2) in vehicle and if no chemical that release SO_2 are included in packages.

Compatibility Groups

Group 1

Recommended transit conditions:

Temperature: 32° to 34°F 0° to 1.5°C).

Relative humidity: 90 to 95 percent

Atmosphere: Normally used on berries and cherries only - 10 to 20 percent CO_2.

Ice: Never in contact with commodity.

Table 3 (continued)

Note: Most members of this group not compatible with Group 6a or 6b because ethylene production by Group 1 can be high, and thus harmful to members of Groups 6a or 6b.

- Apples
- Apricots
- Berries (except cranberries)
- Cherries
- Figs (not with apples, danger or odor transfer to figs: also see Group 6a)
- Grapes (see commodities with special requirements; also see Group 6a)
- Peaches
- Pears
- Persimmons
- Plums and prunes
- Pomegranates
- Quinces

Groups 2

Recommended transit conditions:
Temperature: 55° to 65°F (13° to 18°C).
Relative humidity: 85 to 95 percent.
Ice: Never in contact with commodity.

- Avocados (see Commodities with special requirements)
- Bananas
- Eggplant (also see Group 5)
- Grapefruit, Arizona and California; Florida before Jan. 1 (see Commodities with special requirements - Citrus fruits)
- Guava
- Mangoes
- Muskmelons, other than cantaloupes
  - Casaba
  - Crenshaw
  - Honeydews
  - Persian
- Olives, fresh
- Papayas
- Pineapples (not with avocados, danger of avocaoss' odor absorption)
- Tomatoes, green
- Tomatoes, pink (also see Group 4)
- Watermelons (also see Groups 4 and 5

---

[1] Lipton, W.J. and M. Harvey, Compatibility of fruits and vegetables during transport in mixed loads. MRR-1070, USDA, 1977.

[2] Recommended for 3 to 4 day transit time. Not recommended for long-distance shipping requiring lengthly transit time (more than 4 days).

5. DISCHARGE OF SHIPMENT

Tropical fruits suffer symptoms of chilling injury at treshold temperatures ranging from 8 to 13°C. Chilling of discharged cargoes should therefore be avoided in the winter months in Europe and the USA.

Ideally, fruit should reach the market in an unripe condition. This enables the wholesaler or distributor to manage effectively the fruit at the distribution and retail levels. The practice of ripening fruit in ripening rooms is increasingly being adopted in European Economic Community (EEC) countries for controlled ripening of avocado, mango and papapya (Proctor, 1985). Liquid ethylene-releasing chemicals such as (2-chloroethyl) phosphonic acid (Ethephon or CEPA) can be used as postharvest dips to trigger and accelerate the ripening process. CEPA is, however, registered only for preharvest use in the USA and the legality of its use for ripening of export shipments must be considered by the handler.

In most commercial ripening systems, ethylene is applied as a gas using either the shot, trickle or flow-through method. The shot method employs the rapid injection of C_2H_2 into the ripening room atmosphere. It has the advantage of simplicity, but the disadvantage of requiring frequent room aeration to prevent CO_2 buildup. In the trickle method, ethylene is dispensed into the room in a slow continuous flow. The method is safer than the shot method and requires less room aeration and recharging with C_2H_4. The Flow-through system supplies a constant, ripening-effective blend of C_2H_4 and fresh outside air which passes over the product and out an exhaust port in the room. It has proven to be a safe and efficient method for fruit ripening (sherman and Gull, 1981).

One ripening methods which has some potential for use in rural areas or in decentralized systems is the use of calcium carbide. Carbide, as it is more commonly know, releases acetylene, an analogue or ethylene, on reaction with water. Simple reactors are available and cane be used in partially vented spaces to ripenen or degreen fruits under conditions where ethylene may not be available (Reid, 1985).

Fruits may be stored before being ripened or distributed to markets in importing countries. Temperature management and avoidance of the detrimental effects of ethylene are critical to maintaining quality in stored fruit shipments.

The following practices can be used to minimize undesirable ethylene exposure during storage and marketing:

- Electric forklifts should be used in cold storage rooms, This eliminates an ethylene source as well as a large heat source.

- Trucks and other motor vehicles not in use should be turned off during loading and unloading operations in enclosed areas.

- Ripening rooms at produce distribution centres should be vented to the outside to guard against contamination of adjacent cold storage rooms.

- Strict sanitation practices should be followed to ensure removal of decaying products from storage areas.

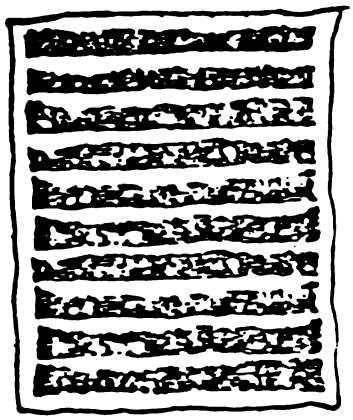
- If outside air is not high in ethylene, it can be used to ventilate the air in storage areas. An air exchange rate of one air change per hour can be achieved by installing a small fan.

- Removal of ethylene by chemical processes. Potassium permanganate, ozone, and activated or brominated charcoal can be effective for theylene removal. Scrubbers are available in a variety of forms (Figure 1).

- Specialized long-term storage facilities can utilize controlled atmospheres (reduced 0_2 and elevated CO_2 levels) to inhibit the effects of ethylene on fruit ripening and, therefore, extend the marketing season.

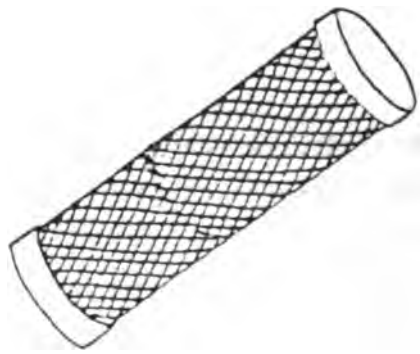
AIR REPAIR™

BLANKETS



Size #1 (10" x 10")
#5 (20" x 20")
#6 (20" x 25")

TUBES



Size #1 (20")

Figure 1. Potassium permanganate scrubbers

- Gas detection kits should be used for on-site ethylene analysis. These kits are available from speciality gas companies. They are relatively expensive and some training is required for efficient operation (Sherman, 1985).

6. SUMMARY AND CONCLUSIONS

Successful penetration of export markets and maintenance of satisfactory trading partnerships can only be achieved through the timely, consistent and reliable supply of high quality produce of defined specification. Strict quality control at all levels of the production-marketing system for tropical fruits is the key to maintaining a high degree of confidence with importers and a high demand for the product.

The benefits of several of the methods and techniques outlines can be readily obtained with very little capital outlay or effort. Two other requirements are important for achievement of successful export programmes in the Caribbean. The first is a critical evaluation of the technical, infrastructural and operational requirements of the industry against a background of thorough knowledge and understanding of the market opportunities for fruits with export potential.

The second requirement is integration of all aspects of the export industry with the injection of investment where necessary, and with the firm commitment to meet the challenges of export marketing of tropical fruits.

TABLE 4. Examples of chemicals registered for postharvest treatments to prevent crop decays caused by filamentous fungi, bacteria, and yeasts

Chemical/crop	Organism	Methods of application and concentration ranges in ppm (unless otherwise indicated)		Residue tolerance (ppm)
***Benomyl* (Benzylate)**				
Bananas	Crown rots, surface molds *Colletotrichum*	Dip or spray	600	1.0 (0.2 in pulp)
Citrus	*Penicillium* Stem-end rot	1) Dip or Spray 2) Spray	1,200 2,400 in wax	10.0 (50.0 in dried pulp)
Pears, apples	*Botrytis* *Penicillium* *Colletotrichum*	Dip or spray	300	7.0 (70.0 pomace) (70.0 pomace)
Pineapple	*Thielaviopsis*	Dip or spray	1,200 to 2,400	35.0 (Fresh market only)
Stone fruits Apricots, cherries, nectarines, peaches, plums, prunes	Fruit rot pathogens *Monilinia* *Penicillium* *Botrytis*	Dip or spray	300	15.0
***Biphenyl* (Diphenyl)**				
Citrus (all)	*Penicillium* & stem-end rot	2 liners/carton	4 lb/1,000 ft²	110.0
Citrus	*Penicillium* & stem-end rot	1) 2 pads/4-5 bushels 2) Wraps	4 lb/1,000 ft² 0.09 lb/1,000 ft²	110.0 110.0
***Sec-butylamine* (2-aminobutane) (Tutane)**				
Citrus, citrus boxes, bins	*Penicillium*	Spray Drench	20,000 10,000	30.0 None
Citrus Grapefruit, lemons, oranges, tangelos, tangerines	*Penicillium* Stem-end rot *(Diplodia, Phomopsis)*	Dip (1-5 min), drench (3 min), or spray (1 gal/30-35 bushels of fruit)	Dilute 14 gal of 98% liq. conc. to 1,000 gal water Adjust pH to 8.0 to 9.0 with HCl, H_2SO_4, acetic or phosphoric acid. May use carbon dioxide or dry ice to carbonate.	30.0
Packing boxes, bins, pallet boxes	*Penicillium*	Drench	Dilute 10,000	-
Calcium hypochlorite				
Fruits, vegetables	Bacteria	Wash 2 min & rinse	25 available chlorine	None Limits: 20 available Cl
Storage bins, packing plants	Molds & yeasts	Brush, spray, swab & rinse food contacting surface with potable water	700 to 5,000 available chlorine	None
Barley malting steep baths	Molds	Steep	100 & 350	None
***Captan* (*N*-[(trichloromethyl)thio]-4-cyclohexene-1,2-dicarboximide)**				
Apples, pears, apricots	*Botrytis, Rhizopus* & *Colletotrichum*	Dip or spray	1,200 to 1,240	25.0
Peaches, nectarines, mangos	Storage rot pathogens	Dip or spray	1,200 to 1,240	50.0
Cherries	Storage rot pathogens	Dip or spray	1,200 to 1,240	100.0
Citrus	Storage rot pathogens *Botrytis, Rhizopus*	Dip or spray	1,240	25.0
Grapes (raisins)	Mold control on fruit on drying trays in fields	Dust	1.5 lb/acre by aircraft 1.0 lb/acre by ground equip.	50.0
Pineapples	Storage rots	Dip or wash	6,000	25.0
Cantaloupes, cucumbers, potatoes	Storage rot pathogens	Dip or spray	1,500	25.0

Continued on next page

TABLE 4 — *Continued*

Chemical/crop	Organism	Methods of application and concentration ranges in ppm (unless otherwise indicated)		Residue tolerance (ppm)
Captan* (*N*-[(trichloromethyl)thio]-4-cyclohexene-1,2-dicarboximide) *(Continued)				
Onions	Storage rot pathogens	Dip or spray	1,500	50.0 (green) 25.0 (dry bulb)
Potatoes	Storage rot pathogens	Dip	1,500	25.0
Packing boxes	Reduction of storage rots, molds due to *Rhizopus, Botrytis* & *Colletotrichum*	Dip or spray	1,200	-
***Dehydroacetic acid, Sodium salt* (sodium dehydroacetate) (DHAS)**				
Strawberries	Postharvest mold growth (*Aspergillus, Botrytis, Penicillium, Rhizopus* & other fungi)	Dip (30 sec)	4,000	65.0
Squash prepared for packaging crate	Postharvest mold	Dip	2,000	65.0
***2,6-Dichloro-4-nitroaniline* (DCNA, Botran)**				
Apricots	*Monilinia* & *Rhizopus*	Spray	900	20.0
Cherries	*Rhizopus*	Spray	1,200	20.0
Nectarines	*Monilinia* & *Rhizopus*	Spray-brush, 30-35 gal of Botran-wax combination/hr	2,556 plus fruit wax	20.0
Peaches (fresh)	*Botrytis* *Monilinia* *Rhizopus*	Dip or spray Spray-brush in fruit wax/12,500 lb fruit Dip or spray Wrap	900 1.0 gal of 3% product 900 0.2% impreg wrap/fruit	20.0 20.0 20.0
Peaches (canning or freezing)	*Botrytis, Monilinia,* & *Rhizopus*	Dip	2.0 lb/75 gal	None
Plums, prunes	*Monilinia* & *Rhizopus*	1) Conventional applicator	2 lb actual/100 gal approved wax emulsion/ 25 tons of fruit	15.0
		2) Low volume applicator	1 lb wax emulsion/ 250 tons of fruit	
	Rhizopus rot alone	Spray brush applicator at rate of 1 gal/ 12,500 lb fruit	1 gal of 9% liquid product in 2 gal wax emulsion/ 12,500 lb of fruit	15.0
Carrots	*Sclerotinia*	Dip (10 sec)	900	10.0
Sweet potatoes	*Rhizopus*	Spray or dip	900	10.0
Formaldehyde				
Equipment (potato)	Bacteria Fungi	Wet	1.0 pt/15 gal soln	
Storage area	Fungi Bacteria	Fumigate	1.0 pt plus 0.5 lb K permanganate/1,000 ft^3 for 5 hr Ventilate.	
Imazalil				
Citrus	*Penicillium*	Spray	2,000 ppm in food grade wax 1,000 ppm	10.0 citrus (temporary)
		Drench	750 ppm	
		Dip	500 ppm	
Methylene chloride				
Citrus	*Penicillium* mold and decay during degreening	Metered over 24 hr period, not to exceed 72 hr	2.7 lb/1,000 • ft	None (exempt)

Continued on next page

TABLE 4— *Continued*

Chemical/crop	Organism	Methods of application and concentration ranges in ppm (unless otherwise indicated)		Residue tolerance (ppm)
Potassium sorbate **(Sorbic acid potassium salt)**				
Prunes (dried)	Molds	Dip	2% (180° F)	GRAS
O-phenylphenol **(Orthophenylphenol) (OPP)**				
Apples	*Penicillium* *Botrytis*	Spray	800 in approved wax	25.0
	Molds	Spray	1 gal (0.5% plus 0.2% thiabendazole) in wax/ 5 tons fruit	
Citrus	*Penicillium* mold & stem-end rot	Spray or foam	8,000 in approved wax	10.0
Nectarines, peaches	*Monilinia*	Spray	2,000-18,000 in approved wax	5.0 nectarines, 20.0 peaches
Plums	Fungi	Commercial	10,000-20,000	20.0
Carrots	Fungi	Commercial	5,000 in approved wax	20.0
Cucumbers, bell peppers	Fungi	Commercial	10,000-25,000 in approved wax	10.0
Tomatoes	Fungi	Commercial	20,000-25,000 in approved wax	10.0
Sodium borate **(Borax) (Sodium tetraborate)**				
Grapefruit, oranges	*Penicillium*	Immerse fruit for 2 to 4 min and rinse with potable water	4% soln at 110° F	8.0 as elemental Boron
Lemons	*Penicillium*	Drench or spray for 2 to 4 min Dry & store without rinse Wash in foam detergent and rinse in potable water after storage and before packing and shipping	3.0% soln at 100° to 115° F	8.0 as elemental Boron
Sodium dimethyldithiocarbamate				
Cantaloupes	Decay organisms	1.0 gal of 40.0% liq conc/35 gal of approved wax emulsion/50 crates of fruit		25.0
Sodium hypochlorite				
Fresh vegetables	Bacteria, mold & yeasts	Dip. Rinse with fresh tap water	55.0 to 70.0 available Cl solution	None
Cannery belts	Molds	Sprinkle; after 10-15 min, brush & rinse with potable water	Dry formulation of 3.25% product formulated with 91.75% trisodium phosphate & 0.01% K permanganate	None
Lug boxes for canneries, packing houses	Mold	Dip Do not rinse	1,600 of available chlorine	
Sodium o-phenylphenate **(tetrahydrate) (SOPP)**				
Apples, pears	Bacteria & fungi	Dips, sprays, flooding, washes, Britex process	0.3% to 3.16% variation in exposed time and fresh water rinse	25.0
		Britex process	0.3% (anhydrous) plus 0.2% thiabendazole in wax	25.0
Bananas	Crown rot, stem rot, *Fusarium, Colletotrichum* & *Thielaviopsis*	1) Brush 2) Brush	2.0% paste Above plus 0.1% each of sulfur, thiram, and ziram	None None 7.0 for thiram
Cherries	*Rhizopus* *Penicillium* *Monilinia*	Flood or spray Rinse in potable water	0.5 to 1.0%	5.0

Continued on next page

TABLE 4—*Continued*

Chemical/crop	Organism	Methods of application and concentration ranges in ppm (unless otherwise indicated)		Residue tolerance (ppm)
Sodium o-phenylphenate **(tetrahydrate) (SOPP)** ***(Continued)***				
Citrus	*Penicillium* Stem-end rot *Trichoderma* *Phytophthora*	Wash, sprays Dips, foams	0.3 to 2.0% at 90°-115° F	10.0
		Washer tank	0.3 to 1.0%, 2-4 min at 115°-120° F	10.0
Citrus (lemons)	Postharvest rots	Atomize	2% in wax emulsion 1.0 gal/5 tons of fruit	10.0
Citrus (lemons for storage)	Molds & rots	Brush	2.75% in wax emulsion	10.0
Nectarines	Fungi	Dip, flood, or spray: Rinse in potable water.	0.5 to 1.0%	5.0
Peaches	Decay	1) Washer Rinse in potable water.	0.6 to 0.64 (30 sec)	20.0
		2) Dip, flood, or spray: Do not rinse.	1.0 gal of 0.2% emulsion/ 68.0 to 3,000 lb of fruit	20.0
		3) Hydrocooler dip or flood Drain Do not rinse.	0.05% in water (15-18 min) at 33° to 35° F at pH 11.5	20.0
Plums (fresh)	Fungi	1) Dip, flood, or spray: Rinse in potable water.	0.5-1.0%	20.0
		2) Dip, flood, or spray: Do not rinse.	2.0% in wax emulsion	20.0
Pineapples	*Thielaviopsis*	Foamer, sprayer, or dip	1.0 in wax emulsion 1 gal/5 tons fruit	10.0
Cantaloupes	Bacteria & fungi	Dip or spray: Drain. Do not rinse.	0.5 to 2.15%	125.0 (10.0 in edible portion)
Carrots	Fungi	Dip, flood, or spray: Do not rinse.	0.05 to 0.1%	20.0
Cucumbers & bell peppers	Bacteria & fungi	Dip, flood, or spray	1) 0.5 to 1.0% (rinse) 2) 25% in wax emulsion. Do not rinse.	10.0 10.0
Sweet potatoes	Black rot, *Botrytis* soft rot	Dip, flood, spray, or foam	1) 0.4 to 1.1% 2) 1% in wax emulsion	15.0
Tomatoes	Bacteria & fungi	Tank dip, flood, spray, and rinse	1) 0.45% (2-4 min) 2) 1.0% (20-30 sec)	10.0 10.0
Crates, field boxes, hampers, lugs, vegetable crates	Bacteria & fungi	Dip, spray, or brush	0.1 to 0.3%	None
Sodium or potassium bisulfite				
Grapes (fresh)	Molds	Sawdust mixture	5 gm for 28 lb lug box	None (GRAS)
		2 pads	5 gm for 24 lb box	None (GRAS)
Sulfur				
Bananas	Crown rot fungi	Paste	0.1% a.i. in combination with sodium orthophenylphenate, 2.0%, thiram 0.1%, and ziram 0.1%	None (GRAS)
Sulfur dioxide **(Sulfurous anhydride)**				
Grapes (fresh)	Molds *Botrytis*	Fumigation followed by exhausting or water spray system	1% for 20 min, weekly intervals of ½% for 20 min	None (GRAS)
2-(4-thiazolyl)benzimidazole **(Thiabendazole) (Mertect)**				
Apples	*Penicillium*	Britex process	0.2% plus 0.23% SOPP in wax	10.0
Bananas	Crown rot	Dip after dehanding and delatexing	6.67 avg oz of 40% product or 0.4 gal of 5.0% flowable suspension/100 gal water	3.0 (0.4 in pulp)

Continued on next page

TABLE 4– *Continued*

Chemical/crop	Organism	Methods of application and concentration ranges in ppm (unless otherwise indicated)		Residue tolerance (ppm)
2-(4-thiazolyl)benzimidazole* (Thiabendazole) (Mertect) *(Continued)				
Citrus fruit	*Penicillium* Stem-end rot	1) Spray, dip, or flood previously 2) 2 other processes using wax emulsions	6.96 lb of 60.0% product or 10 gal of 5.0% flowable suspension/90 gal water	2.0
Pears	*Penicillium* Bull eye rot, *Botrytis*, cluster rot, and nest rot	Dip, flood, or spray. Do not treat for more than 3 min Treat once before or after storage. Do not rinse.	1.5 lb of 60.0%/100 gal	10.0
Thiophanate-methyl				
Stone fruits Peaches, nectarines, plums, cherries, apricots	*Monilinia*	Spray or dip Wax	8.4-11.2 oz a.i./100 gal water. 11.7 to 35.1 oz a.i./100 gal dilute wax/200,000-250,000 lb fruit	15.0
Thiram				
Bananas	Crown rot, stem-end rot, surface molds *Fusarium, Colletotrichum, Thielaviopsis*	1) Spray 2) 2 other processes using brush application of paste for formulations	1.3 lb actual/100 gal of suspension/100 trays of 40 lb fruit each	7.0
***1,1,1-trichloroethane* (methyl chloroform)**				
Citrus Oranges Grapefruit	*Penicillium* decay during degreening	Vaporized in chamber from special equipment or from cloth pads in shallow trays. Enclosed for 24 hr	2.0 qt of formulation/100 ft^3 space	Exempt
Triforine (50W)				
Stone fruits Apricots, nectarines, peaches	*Monilinia*	Dip or hydrocooler Spray Wax/water mix	4 oz a.i./100 gal water/200,000 lb fruit 8 oz a.i./100 gal water/200,000 lb fruit (Do not recirculate) 8 oz a.i./200,000 lb fruit. 1 part wax/7 parts water (Do not recirculate)	8.0
Cherries	*Monilinia*	Dip or hydrocooler	4 oz a.i./100 gal water/200,000 lb fruit 30-60 sec. Drain and flush daily	
Zinc ion-maneb complex				
Caprifig	Endosepsis *(Fusarium)* Molds	Dip	0.8 lb/25 gal water Opened capifigs for 15 min. Drain	None
Zinc petroleum sulfonate				
Baskets, boxes, crates for harvesting fruits, vegetables	Decay, mold & mildew organisms	Dip, softwood (15 sec), hardwood (30 sec), spray or brush	1.0 gal of 15% liquid concentration or 0.25% plus 0.75% copper 8-quinolinolate solution/2 gal odorless mineral spirits	None
***Ziram* (zinc dimethyldithiocarbamate)**				
Bananas	Crown rot, stem rot *Fusarium, Colletotrichum, Thielaviopsis*	Brush to crown areas. paste 0.1% in combination with 2.0% SOPP and 0.1% sulfur		None

SOURCE: Oqawa, J.M. and B.T. Manjii (1984) Control of Post harvest by chemical and Physical Means. In Postharvest Patholoty of Fruits and Vegetables: Postharvest Losses in Perishable crops, Publ. NE-87, UC Bull 1914 (ed. Moline, H.E.)

REFERENCES

1. ASEAN. 1981. A new papaya picking implement ASEAN Food Handling Newsletter, July.

2. CAST. 1984. Irradiation of plant products. Comments from CAST ISSN 0914-4096.

3. CHANDLER, F. 1985. Farm News, 1(3), p.8.

4. COOMES, T.J. and Howlett, J.F. 1985. The regulation of postharvest chemical treatments in the UK and Europe - past, present and future. In Use of pesticides to control postharvest losses in food crops. Chemistry and Industry, January, pp.87-90.

5. EDNEY, K.L. 1985. Fungal rooting in stored fruit In Use of pesticides to control postharvest losses in food crops. Chemistry and Industry, January. pp75-77.

6. Farm News, September 1985, p. 1.

7. International New Product Newsletter. Fruit Coating. August, 1985. p. 1.

8. LA ROSA, A. 1985. Tropical fruit - getting to grips with a worthwhile market. The Courier, No. 92, July-August, pp. 89-91.

9. LIPTON, W.J. and J.M. Harvey 1977. Compatibility of fruits and vegetables during transport in mixed loads. USDA. Marketing Research Report No.1070.

10. MITCHELL, F.G. 1985. Preparation for fresh market-fruits. In. Postharvest Technology of Horticultural Crops. Coop. Ext. Univ. Calif. Sp. Publ. 3311. pp. 18-19.

11. _____ 1984. Reducing handling injuries during fruit harvest. Perishables Handling, Issue No. 55, p. 4. Coop. Ext. Univ. Calif.

12. NICHOLAS, C.J. 1985. Export Handbook for U.S. Agricultural Products. USDA Agriculture Handbook No. 593.

13. PROCTOR, F.J. 1985. Postharvest handling of tropical fruit for export. The Courier No. 92. July-August, pp. 83-86.

14. REID, M. 1985. Ethylene in postharvest technology. In. Postharvest Technology of Horticultural Crops, Coop. Ext. Univ. Calif. Sp. Publ. 3311, p. 71.

15. SCOTT, K. J. 1984. Methods of delaying the ripening of fruits. ASEAN Horticultural Product Handling Workshop Report, ASEAN Food Handling Bureau, Kuala Lumpur.

16. SHERMAN, M. 1985. Irradiation of fresh fruits and vegetables. Handling Florida Vegetables, 85(1), p. 2.

17. _____ 1985. Ethylene in postharvest horticulture. Vegetable Crops Fact Sheet, VC-34. Fla. Coop. Ext. Serv.

19. SHERMAN, M. 1985. Control of ethylene in teh postharvest environment. HortScience, Vol 20(1), pp. 57-60.

20. SHERMAN, M. and Gull, D.D. 1981. A flow-through system for introducting ethylene in tomato ripening rooms. Vegetable Crops Fact Sheet VC-30. Fla. Coop. Ext. Serv.

20. SIMEON, D.T. 1983. Trade of agricultural commodities between Trinidad and Grenada, Study done at Faculty of Agriculture, University of the West Indies, St. Augustine.

21. SINGH, K. and Chauhan, K.S. 1981. Effect of postharvest calcium treatments on the storage life of guava fruits. Indian J. agri. Sci., Vol. 51(1), pp. 44-47.

22. SOMMER, N.F. 1985. Postharvest handling system-tropical fruits. In Postharvest Technology of Hroticultural Crops, Coop. Ext., Univ. Calif., Sp. Publ. 3311, p. 164.

23. SUMBALI, G. and Mehrotra, R.S. 1983. Control of postharvest diseased or temperate fruits by chemicals and treated wrappers. Indian Phytopath. Vol. 36(2), pp. 270-273.

24. USAID (1985) Personal Communication.

ECONOMIC IMPLICATIONS OF PESTS AND DISEASE IN FRUIT MARKETING IN THE CARIBBEAN

by

Michael J. Moran
Director, IICA Office in Barbados

I. INTRODUCTION

Pest and disease problems in fruit marketing can have serious economic impacts for the farmer, buyer, consumer and nation as a whole. Loss of quality due to pest and disease may result in market rejection of the farmer's produce. The consumer may be short-changed in obtaining the expected nutritional value of the product. A country may lose a whole market due to import restrictions of fruit affected by certain pests and diseases.

This paper emphasizes the importance of knowing as much as possible about the economic impact of pest and disease on fruit marketing in the Caribbean. The lack of data about economic losses in this subsystem is acute.

Measurements of economic loss are complicated by the fact that there are many kinds of direct and indirect costs involved. An example of direct cost is the purchase and application of pesticides, insecticides fumigants or biological control measures. Indirect costs may include such actions as those related to research and extension efforts. Other problems of measuring cost is the time span covered by a disease such as moko which can affect expected life span of banana resulting in the loss of two or three years of production.

2. IMPORTANCE OF FRUIT CROPS IN THE CARIBBEAN

Before discussing the economic implications of pest and disease on marketing of fruits in the Caribbean, it is useful to determine the overall importance of this subsector.

2.1 DIVERSIFICATION AND EXPORT

Agricultural diversification has emerged as a priority strategy for transforming the agricultural sector in the Caribbean. This strategy itself is not new. What is new, however, is the concerted effort directed primarily at the export marketing of non-traditional commodities including fruit tree crops.

The following are some examples of recent efforts to promote and develop fruit crop production within the overall crop diversification export/import substitution development efforts:

- Windward Islands - Tree Crop Diversification Projects.

- Barbados: Implementation of National Fruit Orchard Project and Fruit Crop Development.

- Jamaica: Fruit Crop Development Program under Agro 21: plan to establish 3000 acres of papaya, 3000 acres of mango and 1800 acres of pineapple over a four year period commencing in 1983.

- Grenada. Grenada Agricultural Rehabilitation and Crop Diversification Project.

These and many other initiatives reflect the high investment cost. For example, in Barbados, planned capital expenditure for fruit orchard development from 1983/84 to 1987/88 is almost US$2 million.

2.2 FOREIGN EXCHANGE EARNER

It is estimated that the region produced over 500,000 tons of citrus, mangoes, avocados and papayas in 1982. Specific examples of increased production include: Dominica, St. Lucia and St. Vincent. They increased their exports of mangoes from 560,367 ECUs

in 1981 to 981,207 ECUs in 1983 (362 mt to 624 mt respectfully).

Bananas account for about 97 per cent of all foreign exchange earnings derived from export of fresh fruit and vegetables in St. Lucia in 1983; about 88 per cent in Dominica; and approximately 50 per cent in St. Vincent. Haiti exported almost 5000 tons of mangoes to the USA in 1982.

Overall, regional production of fruit crops is expected to double during the period 1985-1995. The major target markets are those located extra-regionally where import restrictions, exemption and quality control are most demanding.

2.3 LABOUR REQUIREMENTS

Reliable data on labour requirements for managing fruit tree crops in the Caribbean are very scarce, due to the many backyard gardens containing fruit trees and other crops. One estimate (C. Weir, E. Tai, C. Weir 1982) indicates that over 60% of all fruit produced in the region is grown on backyard mixed fruit garden system. Consequently, economic importance of fruit farming is very significant for this group. Pest and disease outbreaks could have a major impact on a large number of small and plantation farmers within the region.

2.4 SOIL CONSERVATION AND NUTRITIONAL CONSIDERATIONS

These factors are also paramount when discussing the importance of fruit trees and their output. Most Caribbean fruit contains a high vitamin and mineral content as seen from Table 1.

TABLE 1. Nutritional contents of selected fruits (Calories and nutrients per 100g of edible portion)

FRUIT	Calories	Protein (g)	Calcium (mg)	Iron (mg)	Vitamin A (IU)	Vitamin (IU)	Phosphorus (mg)
Ogange[a]	53	0.8	22	0.5	10	50	n.a
Banana[a]	116	1.0	7	0.5	100	10	n.a
Mango[a]	63	0.5	10	0.5	600	30	16
Avocado[a]	165	1.5	10	1.0	200	15	n.a
Guava[a]	58	1.0	15	1.0	200	200	28
Papaya[a]	39	0.6	20	0.5	1000	50	15
Cashew[a]	590	20.0	50	5	40	5	n.a
W.I. Cherry[a]	36	1.5	8.7	0.2	1017	1500	16.2
Passion fruit[b]	51	0.7	3.6	0.2	717	30	12.5
Soursop[b]	64	1.7	8.8	0.8	n.a	20	29
Tamarind[b]	272	3.1	54	1.0	20	6	108
Sapodilla[b]	98	0.7	28	2.0	5	10	27
Apple[c]	58	0.3	6	0.4	5	6	n.a
Peach[c]	38	0.6	9	0.5	135	7	n.a

Sources: [a] Tropical Fruits - by J.A. Samson, Longmans, London (1980)
[b] Tropical & Sub-Tropical Fruits - S. Nagy & P.E. Shaw, AVI Publ. Conn, U.S.A. (1980)
[c] Food Composition Tables - Caribbean Food and Nutr. Inst. Jamaica (1974)

Source: Fruit Tree Crop Production in the Caribbean Region prepared for Caribbean Development by Weir's Agricultural Consulting Services.

2.5 HUCKSTERS

Fruit marketing is an important economic enterprise for this group of entrepreneurs. Hucksters account for roughly 80-85 percent of all fruit exports to Barbados and Trinidad in 1985. It is estimated that these intermediaries operating from St. Lucia, St. Vincent and Dominica are thought to number over 300 per country. Any pest and disease outburst or import restriction can affect adversely thousands of these hucksters who perform important marketing functions throughout the Region.

3. MARKET IMPLICATIONS

The first step in growing fruit is to decide for whom the produce is being grown. If the consumers have little income and are not concerned about exact size and higher quality or uniformity, high quality and standards are less important than otherwise. However, when produce is to be funneled into more discriminating markets, for export or for processing and storage, it is often necessary to introduce new cultivars, monitor disease control, maturity at harvesting, handling, packaging, grading and transport. The bottom line is the need to guarantee regular supplies and of the quality the consumer wants.

Marketing of fruits to national, regional and extra-regional markets is expected to increase significantly in the near future as seen in the previous section. The high cost of production, transportation, handling, packaging and final distribution will be a useless exercise if the products cannot be sold at a reasonable price. If pest and disease control programs are prohibitively costly they can have a significant impact on determining if the commodities can be marketed profitably. On the other hand, if pest and disease problems are not dealt with adequately, market rejection can occur and/or low price can result, making the farm business of fruit production unprofitable.

3.1 PRODUCE QUALITY

Pest and disease can affect both sensory (colour, size, shape, external defects) and non-sensory aspects of quality, eg., level of pesticide residues. The different growing conditions, harvesting, handling and treatment combined with the natural variability inherent in fruits produce wide variations in produce quality. Some components of quality related to fruit are the following:

Appearance - defects from fungi, virus, insect bud, chemical;

Flavour - defects of off-flavour due to pesticide residues;

Nutritional- defects due to presence of pesticide residues, fungi.

Preharvest factors affecting market quality and related to pest and disease include: planting material, location factors, chemical sprays, cultural practices and overall crop management.

Postharvest diseases and pests directly affecting the marketing of fruit by reducing product quality are anthracnose (avocado, papaya, mango), stem end rot (citrus fruit), black rot (pineapple). In fact such disease organisms not only result in market rejection and/or low prices but disease control measures may act as a barrier to international trade, eg. EDB.

3.2 NON-TARIFF BARRIERS

There are various non-tariff barriers which must be considered for the exported produce in order to ensure that the importing countries regulations are met. These barriers include: quality requirements, import licences/quotas, domestic policies and phytosanitary regulations. I have already discussed the quality issue. Of major importance to this Seminar is the phytosanitary

regulations. This area will be discussed more fully by other participants. Suffice to say that with the increase in trade and traffic, strict regulations will be imposed. As the economic value increases so does the concern with pest and disease outbreaks. For example, recently the USDA-APHIS-PPQ announced new phytosanitary restrictions due to the frequency of recent outbreaks of fruit flies and citrus canker whose eradication costs millions of US dollars.

The cost of inadequate disease control is most evident where produce is for extra-regional markets. The produce must pass through stringent phytosanitary regulations. If not met, the end result may be total rejection of the shipment.

3.3 POST-HARVEST LOSSES

No one knows exactly how much food is lost because losses are highly variable and reliable statistics are few. One recent study (National Academy of Sciences) reported the losses related to fruit in Less Developed Countries (Table 2).

TABLE 2: Reported production and loss figures in less developed countries by fruit species.

FRUITS	PRODUCTION (1000 tonnes)	PERCENT
Bananas	36,898	20-80
Papayas	931	40-100
Avocados	1,020	43
Peaches, Apricots Nectarines	1,831	28
Citrus	22,040	20-95
Grapes	12,720	27
Raisins	475	20-95
Apples	3,677	14

Data from National Academy of Sciences report, 1978. p113.

It has been estimated that postharvest losses often exceed production losses. For example in the Philipines, Pantastrio (1977) pointed out that fruit production was 2,763,443 mt, production values US$403,909,222, losses 28% and loss values US$113,498,490.

Many workshops, seminars and training sessions have dealt with the problem of postharvest losses. Considerable attention has been directed to resolving pre- and postharvest related problems. However, the question is not so much reducing the losses of a particular crop by 20-40% but rather what is the cost to achieve such a reduction. The additional time, effort and cost in terms of labour, chemicals, management, equipment and facilities may make quantum reductions uneconomical. It may cost more than the extra price received for the crop.

The main point here we need to assess carefully is the economic viability of loss reduction measures weighed against the expected economic return for such an investment.

3.4 MARKETING IMPLICATIONS OF SELECTED PESTS AND DISEASES

If the fruit is affected by a disease at harvest time for example, it can result in further losses through the marketing system.

Table 3 illustrates this fact. The lesson to be learned here is that the production and marketing system of fruits is a system and we need to treat it as such - pest and disease affect facilities, plant propagation improvements and postharvest marketing practices and final consumption.

TABLE 3. Pests and diseases and market implications of selected fruit.

FRUIT	Disease and pest	Effect on the fruit	Marketing implications
Avocado	Root Rot	Fruit reduced in size. Tree may bear out of season.	Poor quality. Unstable supply - causing uncertainty for buyers.
	Anthracnose	Deformed fruit.	Impairs eating quality, shortens shelf life, causes fruit rot in storage.
Citrus	Fruit flies	Wrong timing and methods of application of chemical. Absortion of chemical.	High toxicity, environmental contamination.
	Scale Insects	Fruit drops	Loss of marketable fruit associated ants and make harvesting difficult which increased harvest cost and price of products.
	Fruit flies	Heavy crop losses	Loss of marketable produce, uncertain supply - increase risk for buyers.
	Citrus rustmite	Cracking and scaring of skin (orange).	Low quality produce, poor appearance.
	Scab	Retard growth up to 50% for rough lemon and sour oranges.	Quality
Guava	Fruit flies	"Worms" and mishaped fruit.	Quality

TABLE 3 (continued)

FRUIT	Disease and pest	Effect on the fruit	Marketing implications
Mango	Fruit flies Mango seed weevil	Loss of fruit.	Loss of market, e.g. import restrictions Barbados, U.S.
	Anthraenose	Fruit stains, fruit rot and black spots.	Quality - appearance.
Papaya	Mosic virus	Low yields or no fruits.	Loss of supply for market.
	Bunchy Top	Immature fruit.	Continuous deterioration after harvest.
	Anthraenose	Spotting and deterioration of ripe fruit.	Market rejection and/or lower price.

4. ECONOMIC IMPLICATIONS IN THE MARKET

In this age of increasing ease and frequency of travel from island-to-island and continent-to-continent, no one questions the obvious fact that plant pathogens may also move inter-continentally and among islands with greater ease. In recent years it was stated that the eradication of citrus canker is one of the few examples of successful disease site (D. Thurston 1984). However, as we all know, another outbreak occurred in Florida in 1985 causing losses of millions of dollars. The loss due to the same disease in Florida was estimated at US$6.5 million between 1914 and 1931.

The following examples further illustrate the major economic impact which disease and pests can have on trade.

4.1 MOKO DISEASE OF BANANAS

This disease was unknown in the Windward Islands until recently when it was reported in Grenada in 1978 (Cronshaw and Edmunds, 1980). It is endemic in Trinidad and is thought to be responsible for the decline of the banana industry in this country (Small, 1982). Since its discovery in Grenada the economic impact of this disease has been quite considerable, estimated at EC$5.6 Million (US$2.1 Million) (Pollard, 1983). One would expect at least a similar impact should this disease be introduced into St. Vincent or any of the other islands now free of the disease.

The disease is a major problem of the commercial banana, not so much for the direct losses it causes, but for the expensive preventive measures used to keep it under control so that the produce is acceptable in the international markets.

4.2 MANGO SEED WEEVIL

The discovery of the mango seed weevil in St. Lucia in 1984 has caused a serious set back to trading mangoes between Barbados

and St. Lucia. The hucksters trade in mangoes was banned resulting in the curtailment of revenue to St. Lucia from that crop. In 1983, hucksters from St. Lucia had traded more than a quarter million pounds of mangoes with Barbados at a value of EC$156,438 in export earnings to the economy. Such a loss is of significant importance to a small island nation.

4.3 EHTYLENE DEBROMIDE QUARANTINE

In the Caribbean Island Nations, a curtailment of the use of EDB has threatened the exportation of mangoes. However, several nations have reported the initiation or expansion of commercial planting of other tropical fruit such as guava, soursop and carambola with an eye towards exportation to the United States. These fruit are also affected by a suspension of EDB.

Mexico accounted for 81 percent of all US imports of mangoes from 1977-1982 and Haiti exported about 17 percent of the 29,395 tons imported to the U.S in 1982.

4.4 BANANAS

"Fusarial wilt of bananas is similar to late blight of potatoes in Ireland in respect to the profound influence it has had on the history, economic level being, and political stability of a region. Stover(1972) states, "Over a period of 50 years 100,000 acres of bananas were destroyed or abandoned in Central and South America because of fusarial wilt. The economic losses due to abandoned buildings, villages, potential earnings never realized, and costs of maintaining stability in regions devastated by unemployment would be many millions of dollars more."

4.5 PAW PAWS

In Barbados, the Bunchy Top virus disease wiped out the entire paw paw production four to five years ago within less than a

year. Although the total cost of this loss is very difficult to measure the process of bringing paw paw back into production again, has been considered. When we add up the time and expenses of research, equipment, cultivar selection, propagation and commercial testing, the economic implications of such a disease outbreak become very clear.

5. CONCLUSIONS

The impact of crop losses caused by disease, although experienced directly by the producers, filters through the food system eventually to the final consumer. The social and economic effects of substantial crop loss are more apparent than the marginal losses that agriculture sustains yearly. e.g., loss of market, employment, capital investment etc.

Expertise from other disciplines needs to be tapped to enable evaluation of the socio-economic implications of crop loss. A multidisciplinary approach is required with a view of the production and marketing phases as a system. Understanding yield/market loss as a key element in the management of pest and disease problems is very important. Cost-benefit decisions on strategies aimed at specific pests and diseases need to include the relationship between pest quantities and their consequence on the yield and marketing of that crop. Furthermore, crop situation reports to facilitate recommendation for alternative pest management strategies in view of specific market requirements should be given serious consideration.

The above issues have important implication for the future development of program aimed at the actual quantitative and qualitative extent of the economic importance of pest and disease on fruit marketing in the Caribbean. Some specific areas for immediate action which may lead towards this direction are the following:

- Project Design - multidisciplinary approach in preparing projects which incorporate as a minimum production, marketing and plant protection specialist.

- Training - design of training programs which include economic analysis of pest and disease control for a marketing-production perspective.

- Research - determination of an economic threshold range for accurate assessment of pest and disease control.

- Multidiscplinary technical cooperation advisor and teams to identify major constraints and alternative solutions within the systems perspectives, eg., production, marketing and plant protection.

LIST OF REFERENCES

1. Blades, Hayden. 1982. Trade and production of food commodities in Caricom countries with special reference to fruits and vegetables. Caribbean Food Crop Society, Barbados. Vol XVIII. p352.

2. Brathwaite, Chelston W.D. and Gene V.L Pollard. 1981. Urgent plant pest and disease problems in the Caribbean. Proceedings Society for Plant Protection in the Caribbean, Kingston, Jamaica, November 22-27. IICA miscellaneous publication 378 ISSN 0534-5391. Trinidad and Tobago.

3. British Development Division. 1984. Post Harvest technology of commercial perishable crops. 11 short courses held in St. Lucia.

4. Cavin, George, W. Bollon, J. Cummins. 1984. Report of U.S. Aid fact finding team and ethylene dibromiate quarantine program used on tropical fruits in Caribbean Basin Initiative Countries. March.

5. Food and Agriculture Organization. 1981. Food loss prevention in perishable crops, Rome.

6. Humphrey, Sean, M. Wiler and H.Riley. 1985. A diagnostic presentation assessment of the production and marketing systems for mangoes in the Eastern Caribbean. Working Paper No. 23 Michigan State University, Michigan.

7. Lucas, Robert. 1982. Problems and progress in the processing of fruits and vegetables in the region. Caribbean Food Crop Society, Barbados. Vol XVIII. p370.

8. Marte, R and O. Thomas. 1984. Proceeding of The Fruit Crops Seminar in Barbados, Graeme Hall, Christ Church, Barbados, November 21 - 24, 1984. MAFCA/IICA.

9. National Academy of Science. 1978. Postharvest food losses in developing countries, Washington, D.C.

10. Pollard, G.V. 1983. Report on the economic impact of moko disease of bananas in Grenada. Report submitted to IICA Office in Trinidad and Tobago, W.I. September.

11. Saul, Hugh. 1982. Problems and progress in marketing fruits and vegetables in the Eastern Caribbean Region. Caribbean Food Crop Society. Barbados. Vol XVIII. p338.

12. Teng, P.S. and R.J. Oshima. 1983. Identification and assessment of losses. Problems and Challenging Problems in Plant Health, (ed.) T. Kommedahl and P.H. Williams. The American Phytopathological Society, St. Paul. Minnesota.

15. Thurston, H. David. 1984. Tropical plant diseases. The American Phytopathological Society, St. Paul, Minnesota.

16. Weir, C and E. Tai. 1982. Fruit tree crop production in the Caribbean Region. Caribbean Development Bank.

COUNTRY PAPER - BARBADOS

by
J. Jones, Entomologist
O. Thomas, Virologist/Pathologist
S. Skeete, Agronomist
Ministry of Agriculture and Natural Resources (MANR)

1. INTRODUCTION

Barbados lies within the humid tropics, its climate being strongly influenced by the northeast trade winds. Precipitation is the most variable climatic factor showing variation within the island as well as annual and seasonal variation. There is usually low rainfall between January and May.

The larger part of soils in Barbados is limestone derived and only those in the Scotland District deviate from this calcareous nature, and tend to be clayey.

/The main export crop of Barbados is sugar cane. However, with the recent problems in sugar cane marketing there had developed a massive drive towards a diversification programme. Of the various crops cited fruit trees have been selected as a subsector for increased development. This is particularly so for the Scotland District but the programme is in no way confined to planting in this area.

2. FRUIT CROP PRODUCTION

2.1 SPECIES AND CULTIVARS

The fruit tree programme in Barbados currently focuses on the following main species:

Mango	*Mangifera Indica*
Avocado	*Persea Americana*
Citrus	*Citrus* spp. oranges, limes, grapefruit
Barbados Cherry	*Malpohia glabra*
Pineapple	*Anana comosus*
Paw Paw	*Carica papaya*

Other species which are produced in smaller number but have a growing potential are:

Soursop	*Anana nuricata*
Guava	*Psidium guajava*
Passion fruit	*Passiflora edulis var flavicaipa*
Gooseberry	*Phyllantus acidus*
Granadilla	*Passiflora quadrangularis*

In addition there have been recent introductions of nontraditional fruit trees such as Black sapote, (*Diospyros digyna*) imbe (*garcinia livingstonii*), Canistel (*Pouteria campechiana*) and Ceylon Gooseberry (*Dougalis hebecarpa*)

For each of the main fruit species there are various cultivars that have either been established already in Barbados or are presently being introduced (Table 1.)

Table 1. Some various fruit characteristics by cultivar, seasonality and quality.

Species	Cultivars	Fruit maturity or seasonality	Comments on fruit quality etc.	Other Comments
Mango	Julie	May - August	Not so attractive but popular locally.	
	Imperial	May - August	Large fruit	Susceptible to Anthracnose
	Ceylon	May - August	Attractive fruit; productive.	
	Graham	May - August	Fruit suffers internal breakdown.	
	Kent	July - August[1]	Delicious, balanced flavour.	
	Keitt	August - Sept.[1]	Not so attractive; good flavour.	Tolerant to Anthracnose.
	Haden	June - July[1]	Strong flavours.	Susceptible to Anthracnose.
	Palmer	July - August[1]	Strong flavour; high productivity Large fruit.	Susceptible to Anthracnose.
	Irwin	June - July[1]	Mild taste and fragance; good colour.	Susceptible to Anthracnose.
	Tommy Atkins	July - August[1]	Good production; good colour.	Susceptible to Anthracnose.

Table 1 (continued)

Species	Cultivars	Fruit maturity or seasonality	Comments on fruit quality etc.	Other Comments
	Carrie	June - July[1]	Mainly for back-yard.	Resistant to Anthracnose.
	Sensation	July - August[1]	For commercial or backyard	Susceptible to Anthracnose.
Avocado	Pollock	June - August[1]	Big fruit, good productivity.	
	Symmonds	June - August[1]		
	Waldin	June - August[1]	High productivity.	
	Wilson Popenoe	June - August[1]	Long neck type.	
	Hall	Sept. - Oct.[1]		
	Booth 7	Sept. - Oct.	Productive.	
	Booth 8	Sept. - Oct. Oct. - March	Very productive. Good productivity	
	Gripina	Oct. - Jan.		
	Choquette	Oct. - Jan.	Large fruit.	
	Lula	Oct. - Jan.	Productive.	
	Melendez	Oct. - Jan.		
	Avila	Oct. - Jan.		

Table 1 (continued)

Species	Cultivars	Fruit maturity or seasonality	Comments on fruit quality etc.	Other Comments
Orange	Parson Brown	Oct. - Dec.	Quality of juice good if fully mature; poor colour; seedy.	
	Valencia	Feb. - May	Good quality; seedless.	Stores well on tree.
	Pineapple	Dec. - Feb.	Good colour; seedy; good for processing.	
	Navel	Oct. - Dec.	Seedless; good flesh texture.	Does not perform well in tropics.
	Jaffa	Dec. - Feb.	Seedless; erratic bearing.	Suffers from black rot in central.
Grapefruit	Marsh Seedless	Oct. - Jan.	Seedless; good quality; good for juice.	Does not make good sections.
	Thompson Pink	Oct. - Jan.	Similar to March but flesh is pink.	
	Duncan	Oct. - Jan.	Seedy; good for canned sections; immune to sour orange scab.	
	Triumph	Oct. - Jan.	Seedy; high quality	Does not have typical grapefruit bitterness.
	Foster Pink	Oct. - Jan.	Seedy.	

Table 1 (continued)

Species	Cultivars	Fruit maturity or seasonality	Comments on fruit quality etc.	Other Comments
Grapefruit	Claybury	Oct. - Jan.		
Limes	West Indian	May - Dec.	Seedy.	Susceptible to wither tip.
	Tahiti		Seedy; large fruit good quality.	Not susceptible to wither tip.
Mandarine and mandarine-like	Dancy		Does not store well on tree; good for tropics but seedy.	Erratic bearing.
	Murcott		Seedy.	
	Ponkan	Early	Good for tropics; low acidity; tender peel.	Must be handled carefully.
	King	Late	Seedy; good quality.	
	Orlando Tangelo		Commercially seedless.	
	Ortanique		Good fruit; does well in cool tropics.	Withstands shipping.
Barbados Cherry	B - 17[2]	June - Oct.	Very high ascorbic acid content.	Good for commercial use.
	Florida[2] Sweet	June - Oct.	Sweet, large fruit.	Good for backyard.

Table 1 (continued)

Species	Cultivars	Fruit maturity or seasonality	Comments on fruit quality etc.	Other Comments
Pineapple	Smooth Cayenne	July - Sept.	Large fruit; stores well.	Good for export.
	Antigua Black	July - Sept.	Small fruit; very sweet.	Does not store well.
Paw paw	Homestead	Year-round	Good quality; medium size fruit, mainly round.	
	Cartagena	Year-round	Large fruit, good quality:	
	Solo Hawaiana	Year-round	Small fruit.	Good for market export.

[1]Peak season.

[2]If under irrigation, bearing is year-round.

The following is an outline of the cultivars involved (see Table 1).

2.1.1 Mango

The most popular cultivars locally are Julie, Ceylon, Imperial and Graham. At Haggatts Orchard there are also Floridan cultivars such as Kent, Keiff, Haden Palmer, Irwin and Tommy Atkins. These tend to be later bearing and also more adaptable to export markets.

More recent introduction include Glenn springfield and Carrie.

2.1.2 Avocado

Over the past three (3) years a wide range of cultivars have been introduced from Florida and the Dominican Republic:

- Early cultivars: Pollock, Symmonds, Waldin, Wilson Popenoe.
- Mid-season cultivars: Hall, Booth 8, Booth 7.
- Late cultivars: Semil 34, Criping, Choquette Lula; Melendez; Avila.
- Recent introductions: Butler

2.1.3 Citrus

2.1.3.1 Orange

Cultivars established at Haggatts are Valencia, Navel, Jaffa, Parson Brown. More recently the following

More recently the variety, smooth Cayenne has been introduced from Martinique and has been established at Haggatts. This variety produces a large fruit which also stores well.

2.1.6 Papaya

Production since 1983 has been from three (3) main strains. These are Solo Hawaiana, Homestead and Cartagena. These have all shown tolerance to the bunchy top problem.

2.2 AREAS OF PRODUCTION

Fruit tree production has been and still is to a large extent a "Backyard" effort, but there is a growing tendency towards non-government commercial orchards.

This is clearly seen in Table 2, which shows the distribution of plant sales to the public over the period, 1975-1984.

Table 2. Total plant sales by species, 1975-1984.

Species	No. sold 1975-84	Frequency Distribution of Plant sale (%) 1-5	6-10	11-20	21-40	41 and over
Mango	6628	91	7	1.5	0.5	-
Avocado	8707	91	6	1	0.5	0.5
Citrus	30252	70	25	3	2	0.5
Barbados Cherry	4007	90	5	3	2	0.2
Papaya	2536	88	9	2	0.3	0.3
Soursop	871	96	2	0.3	-	-

However this distribution table suggest that there is a slight tendency for persons to plant small orchards of citrus and cherry.

In an case a significantly larger number of citrus plants were sold during the last decade as compared to other species. There

improved material has been introduced:

- Three (3) selections of Valencia
- Pineapple
- Parson Brown.

2.1.3.2 Grapefruit

Orchards at Haggatts consist of Triumph Foster Pink, Claybury and Marsh. Recent introduction: Marsh seedless; Duncan Thompson Pink.

2.1.3.3 Limes

Production has consisted mainly of West Indian and Tahiti lime.

2.1.3.4 Other Citrus

Mandarin and Madarin-like: There were recent introductions of Parson special Mandarin, Murcott, Ponkan, King, Orlando, Tangalo and Dancy Tangerine.

2.1.4 Barbados Cherry

Cherries were formerly propagated by seed mainly with a small portion being done from cuttings.

Recently cultivars were introduced from Florida and these are being propagated vegetatively. The cultivars are B-17 and Florida Sweet. The former is for commercial production while the other is more suitable to backyard production.

2.1.5 Pineapple

The first variety introduced to Barbados was Antigua Black. This variety is very sweet but does not store well.

has been an overall increase in the acreage of the species involved here (see Table 3).

Table 3. Fruit species production, government and private, two decade comparison.

Species	Acreage up to 1974		Acreage from 1975-1984			Total in 1985
	Government	Private	Acreage Government	Private		
Mango	5	129	4	12	132[d]	282
Avocado	10	30	-	1	89[d]	130
Citrus	15	63	14[a]	7	225[d]	309[e]
Cherry	20	No figure available	10[b]	1	30[d]	61
Papaya			3	3	-	6
Guava	1	No figure available	25		13[d]	39
Mixed i.e. Soursop Jamoon, Gooseberry etc.	5		53			58
Pineapple			3[c]			3

a = Limes in Scotland District (1 acre is Tahiti lime)
b = 3 acres conservation & 1 acre experimental plot
c = 80% smooth cayenne
d = Scotland production
e = Mainly for conservation (Scotland District)

2.3 ECONOMIC IMPORTANCE OF EACH SPECIES

Fruit imports in Barbados represent about 25% of the food import bill. The largest volume of imports has been for citrus, particularly oranges. In comparison a lesser quantity of mango has been imported in the last decade and a noticeably smaller amount of avocado (see Table 4).

Table 4. Average annual imports of fresh fruit over past decade, by species, tonnage, and value.

Species	Imported (tons)	Value (1 000)
Mango	192	136
Avocado	16	10
Oranges	877	1006
Grapefruits	274	189

An analysis of fruit production and marketing carried out by Inter-American Institute for Cooperation on Agriculture[1], demonstrated that Barbados has a degree of self-sufficiency of fruits between 50% and 60%.

It would seem then that there is an opportunity for import substitution by increased production.

However it should be noted that local production and import trends have shown no clear relationship. Imports appear to be more closely related to the production season of the exporting country and the peak consumption periods of Christmas and the tourist season[2].

So that while the potential for import substitution exists, some consideration might have to be given to control of imports in order to achieve the goal.

One fruit crop that is being exported significantly from Barbados is the Barbados cherry. Extra-regional markets have been encouraging to the point that the Government of Barbados is expanding the acreage of cherry by at least 100 acres.

(1) J.S. Lohoar. 1981. An analysis of food self-sufficiency in Barbados, IICA, Barbados. p.13.

(2) Maynard. 1980. Fruit trees production in Barbados. IICA, Barbados.

2.4 PRODUCTION SYSTEMS

2.4.1 Mango

Spacing is generally 8m x 8m, though smaller trees like Julie can be planted at 6m x 8m. Some plantings of larger trees may be extended to 8m x 10m.

Fertiliser application follows the general rule of 0.5kg. Kg./12:12:17:2[(1)] per year for each year of growth of the tree. This is split into four (applications). Foliar spray is also sprayed when applying insecticide/fungicide.

Weed control has been mainly manual but lately the herbicide Paracol (Dioron and Paraquat) has been used with increasing frequency. This is applied at 3.9 fl.oz./gal of water and gives control for about 1½ to 2 months.

Hyvar X and Simazine can be used for pre-emergent control of weeds. Round-up is not recommended for mango since it shows some toxicity especially on young trees.

2.4.2 Avocado

Spacing is about 8m x 8m generally. This may be increased up to 8m x 10m for large spreading cultivars like Pollock.

Fertilizer application follows the same as for mango. However, it may be desirable to apply iron chelate since avocado is more sensitive to lime-induced chlorosis than other fruit crops. The rate applied will vary from 50-440g of Sequestrene-138/tree.

---

(1) Commercial formula

Weed control is largely manual. Herbicide control can be effected by use of paraquat at 1.5 fl.oz./gal of water. In orchards with perennial weeds round up is used carefully to control them. Paracol is used also to give persistent control, especially in the wet season.

N.B. Hyvar X should not be used for Avocado.

2.4.3 Citrus

Spacings are (meters):

- Oranges	- generally	7 x 7
- Grapefruit	- "	8 x 8
- Limes		7 x 7
- Manderin		7 x 7

Where dwarf plants are used spacing can be used.

2.4.4 Barbados Cherry

Spacing may be from 6m x 3m to 6m x 6m. As with other fruit crops 12:12:17:2 is used, and at the same rate.

Weed control is manual in the early stage. However paraquat can be used for chemical control. Paracol gives a more persistent control.

2.4.5 Pineapple

This crop is grown on a ridge and furrow system. Ridges are one meter apart and planting consists of a staggered double row on the ridge. The distance between rows is 0.30m while intra-row spacings is 0.35m.

Fertiliser application is done with a mixture of Ammonium Sulphate, Muriate of Potash and Superphosphate. This is applied every three (3) months.

Weed control involves first a preemergent application of Karmex. Paracol has been used in furrows to control weeds at a later stage of crop development.

2.4.6 Papaya

Spacing can range from 2.5m x 2.5 to 4m x 4m. The former spacing is commonly used at Haggatts. Where mechanical harvesting will be done, a spacing of about 2.5m x 4.5m is recommended.

At planting 0.125 kg. of 12:12:17:2 is spread to each hole. The same amount is applied to each plant monthly for the next three months. Subsequently, ½ lb/tree may be applied every three months.

Inter-cropping has been done at Codrington where sweet peppers have been grown in the intra-row space between plants in the early stage of the paw paw crop.

It must be noted that the key to maintaining healthy paw paw plants lies in maintaining a good management programme.

2.5 GENERAL OPERATIONS

In some of the agronomic operation performed on fruit trees there is little variation for different species. These will now be dealt with.

2.5.1 Pruning

At Haggatts the pruning operation is done mainly to remove dead wood from all trees. This is especially important for avocado which is readily infested by wood ants. Pruning is also aimed sometimes at removing branches of trees which are touching the ground (especially in citrus).

2.5.2 Irrigation

All species are irrigated where possible in the dry season. Irrigation, is largely done by sprinkler, but a few orchards have facilities for drip irrigation.

In some areas where terrain is difficult, fruit trees are sustained in drought periods by a system of "Bowser and Buckets". However this is not the general trend since in the overall policy of fruit development the importance of irrigation has been well accepted and planting sites for commercial orchards are carefully selected.

This is especially so for Barbados Cherry which is very responsive to irrigation and will bear all year round as long as adequate moisture is provided. The same for West Indian limes.

2.5.3 Spacing

Table 5. Spacing of various fruit trees.

Species	spacing (m)		
Mango	(6 x 8)	to	(8 x 10)
Avocado	(8 x 8)	to	(15 x 15)
Oranges	(6 x 6)	to	(10 x 10)
Grapefruit	(7 x 7)	to	(11 x 11)
Limes	(6 x 6)	to	(8 x 8)
Mandarins	(5 x 5)	to	(8 x 8)
Barbados Cherry	(6 x 3)	to	(6 x 6)
Papaya	(2.5 x 2.5)	to	(4 x 4)

2.6 SEASONALITIES (See Table 6)

2.6.1 Mangoes

Cultivars such as Julie, Ceylon Imperial, and Ceylon are available between May and August. Other Florida cultivars like Palmer are later bearing and go up to October.

2.6.2 Citrus

Early types of oranges are in season from September to December. Later cultivars are from January to March.

2.6.3 Limes

If grown under rain-fed conditions the season is May to December. However with irrigation this cane be extended through the rest of the year.

2.6.4 Grapefruit

The season is generally from October to January. where there is adequate moisture another peak fruit period could occur between June to July.

2.6.5 Cherry

If under irrigation this crop will bear all year round. For rainfed growth the season is from June to October.

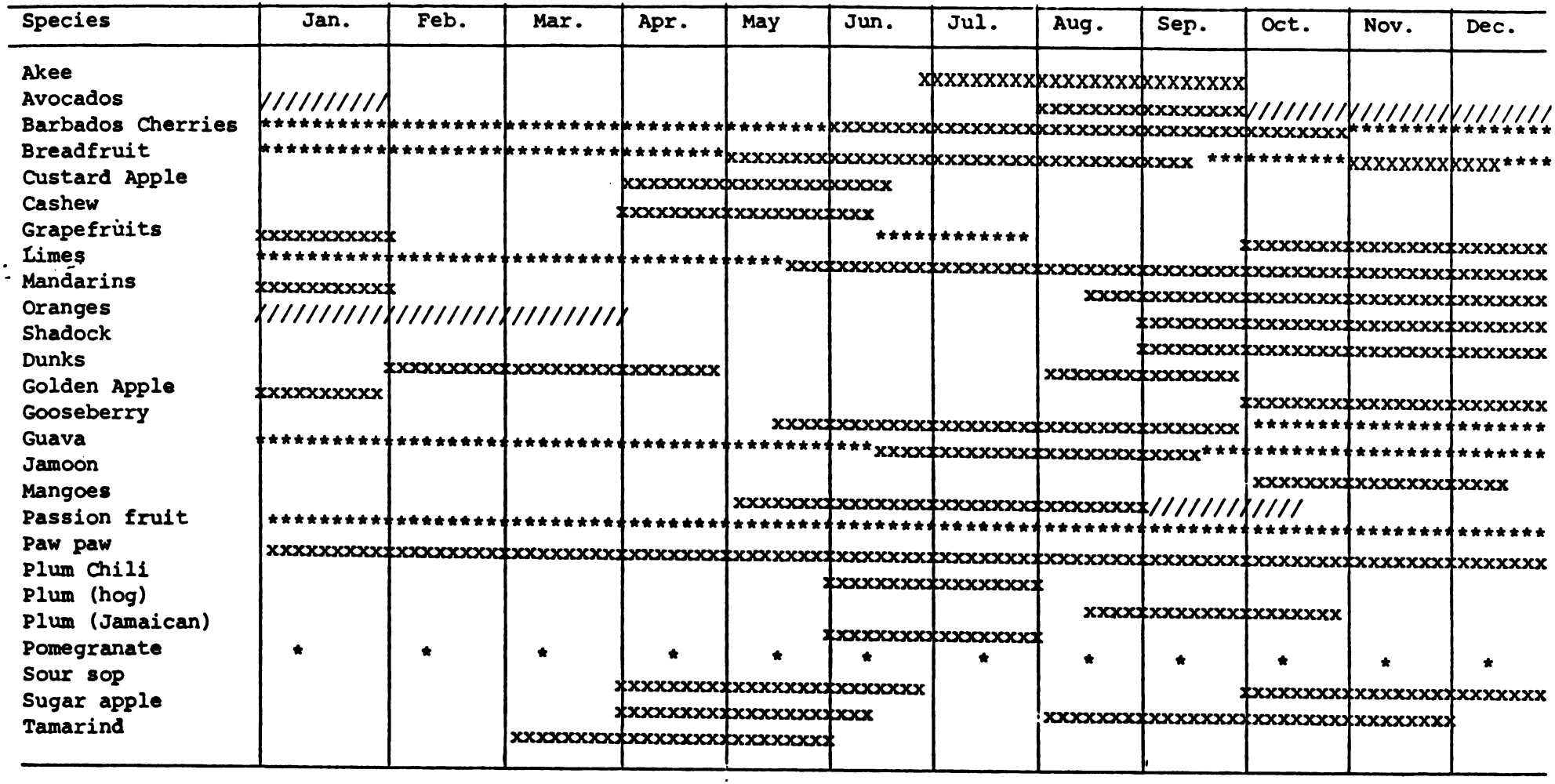
2.6.6. Pawpaw

The crop will bear all year round.

2.6.7 Soursop

Two peaks are observed during the year. The first is from April to June while the other season is from October to December.

TABLE 6. Seasonality of Fruits in Barbados, by species and month



SOURCE: Fruit Crop Development Project, MAFCA/IICA: Phenological Observations 1984-85.

Legend: Peak xxxxxxxxxxxxxxxx
Late clones ////////////////
Depending on moisture **********

2.7 PESTS OF IMPORTANT FRUIT CROPS

2.7.1 Mango Pests

Isulaspis isularis (snow scale)	-	major pest.
	-	aggregates on leaves and fruit.
	-	causes bronzing of fruit.
Dialeurodes sp	-	causes premature falling of leaves.
	-	reduces plant potential through sooty mold formation.
	-	serious in some areas.
Selenothrips rubrocinctus-*Thrips tabacci*	-	minor pests affecting both leaves and fruit.
Pseudococcus sp (mealy bugs)	-	minor pests.
Loxigilla noctus (brown sparrow) / *Coereba flaveola* (yellow sparrow)	-	major pest of ripe fruit.

2.7.2 Cherry Pests

Orthezia sp (white flies)	-	major pests causing sooty mold.
	-	leaves and stems become quickly covered limiting photosynthetic activity.

Icerya purchasi (Cottony cushion scale)	-	usually minor pests on leaves, stem and fruit.
	-	occasionally in large numbers on isolated plants.

2.7.3. Avocado Pests

Xyleutes punctifer (Cossid moth)	-	major pest.
	-	larvae feed within the stem and causes death of the stem, branches or of the plant.
Selenothrips rubrocinctus	-	major pests.
	-	bronzing of leaves and fruit.
Scales) Mites) unidentified	-	minor pests on leaves and fruits.
Trialeurodes sp	-	losses associated with sooty mold.
	-	may be severe in some areas.
Nasutitermes sp) *Cryptotermes* sp) termites	-	cause problems in older plants by damaging the roots of stems of plants.

2.7.4 Citrus Pests

Anaspis citri)
(citrus snowscale)

Sassetia oleae) (Black scale)) *Icerya purchasi*)	-	may cause significant damage to leaves and fruits.
Myzus persicae) (melon aphid)		
Aphid gossypii) (cotton aphid)) *Toxoptera* sp) (citrus aphid))	-	may be serious in complex, cause distortion of young leaves and impair growth rate of plant.
Panonychus citri (Citrus red mite)	-	occasionally attains serious pest status.
Dialeurodes citrifolia (white flies)	-	major pest associated with sooty mold.
Diaprepes abbreviatus	-	minor pest, larvae are root borers.
Xyleutes punctifer	-	minor pest, tunnels through the stem causing death of terminal pests of the stem.
Nasutitermes sp) *Cryptotermes* sp)	-	associated with older plants, and may affect the stems and roots.
Slugs	-	may be serious pests of younger plants.
	-	defoliators.

2.7.5 Pawpaw Pests

Empoasca spp	-	major pests as vectors of bunchy top.
Myzus persicae) *Teramychus urticae*) *Dialeurodes* sp)	-	minor pests.
Loxigilla noctus) *Coereba flaceola*	-	inflict serious damage on ripened fruits.

2.7.6 Soursop Pests

Bephratellodies paraguayensis (soursop wasp)	-	bores through young fruit and develops within the seed.
	-	adult exit holes very obvious on developed or ripe fruit.
Scales (complex)	-	may reach very damaging levels if untreated.

2.8 PEST CONTROL STRATEGY

By far the most visible problem on fruit trees is sooty mold associated with white fly infestation, and a complex of scales and thrips. An active fruit tree spray programme employs largely the use of Malathion and a refined oil e.g. Triona against this complex. Organophosphates, carbamates or pyrethroids are usually effective against external feeders.

Mites tend to be more problamatic and must be controlled by an acaricide e.g. dicfol to prevent economic injury.

Regular chemical applications are discouraged in orchard crops because of the potential for natural or biological control in this system.

The importance of such caution is underscored by the successful classical biological control of white flies by *Hyperaspis* sp in cherry orchards and citrus black fly on citrus. In general, aphis, white flies and scales are kept under partial control by predators or parasites, and inundative releases of these natural enemies may be more appropriate than chemical methods.

Control of root or stem borers is more difficult to achieve. The larvae of *Xyleutes punctifer* tunnel through the stems of the host plants where they remain until adult emergence. Affected parts of the plant should be cut and burnt, and chemical treatment with an organophosphate every two or three weeks may prevent further egg deposition on the plant. A similar approach is recommended for the control of *Bepharactelloides paraguayensis* on soursop. All fruits should be destroyed and preventative chemical applications used.

Leaf hoppers may be controlled by regular conventional insecticides, but a more rational approach of selecting for resistant varieties is being vigorously pursued.

The plant quarantine system attempts to prevent introduction of important pest species from regional and extra-regional sources. In this regard, importation of fruit and fruit material must conform to certain plant quarantine regulations. Importations are prohibited from areas known to have serious pests. Of particular concern with respect to fruit are the following pests:

- The mango seed weevil - *Strenochetus mangiferae* - reported in a few West Indian territories.

- Fruit flies - *Dacus* spp.
  - *Anastrepha* spp.
  - *Ceratitis* spp.
  - *Toxotrypana* spp.

2.9 DISEASES OF IMPORTANT FRUIT CROPS

The major diseased recorded are of virus aetiology and the most common ones found are fungus caused, and hunger signs (deficiency of nutrients). Bacterial diseases of fruit trees are not known to occur in Barbados.

Leaf diseases of fruit trees are the most common problems reported and these are mainly of the sooty mold complex, leaf spots, blight, necrosis and chlorosis. Some leaf necrosis and chlorosis are mainly due to poor nutrition. General unthrifitiness is due to mal-agronomic practices which is a concommitant effect of the wide-spread paucity of knowledge with respect to cultural practices. Most of the disease conditions reported have in some way affected the productive capacity of the fruit trees.

Another area of concern with respect to fruit crop pathology is post-harvest irregularities. This are accounts for more than 50% of the reported problems. Too often growers suffer great loss of fruit during storage. These storage losses occur because of poor handling and harvesting practices, and improper preharvest care. Some of the postharvest problems reported are directly due to mechanical damages sustained during harvest while others are directly pathologically related.

2.9.1 Major Diseased of Fruit Crops in Barbados

The major disease occur with about 14 different symptom categories and are caused by biotic or abiotic agents. Some of the symptoms associated with the major diseased are:

- Root and subterranean rots.
- Tree die-back (dying twigs and branch ends)
- Surface growth parasitism (mildew and sooty mold).
- Bark and trunk lesions and gumming.
- Fruit spots.

2.9.1.1 Major Avocado Diseases

The major avocado diseases and causal agents are:

	Diseases	Causal agents
Fruit Diseases:	Anthracnose	*Colletortichum* sp.
	Scab	*Sphaceloma persea*
	Fruit Rot	*Glomerella*
Leaf Diseases:	Anthracnose	*Collertotrichum* sp.
	Sooty Mold	*Asteridiella perseal*
Root Diseases:	Root Rot	*Phytophthora* sp.
	Collor Rot	*Phytophthora* sp.

The other diseases occuring that are of minor importance are:

Leaf Spot	*Cerlospora* sp.
Apgal Rust	*Cephaleuros* sp.

2.9.1.2 Major Mango Diseases

The major mango diseases are:

	Diseases	Causal Organisms
Fruit Diseases:	Anthracnose	*Glomerella cingulata*
	Fruit Rot	*Colletotrichum* sp.

	Tear Stain	*Colletotrichum* sp.
Stem and Leaf Diseases:	Blossom Blight	*Colletotrichum*
	Mildew	*Odium* sp.

Sooty mold caused by any one or more of *Aithalodesma*, *Antennularia* or *Melioloa* spp. and leaf spotting caused by *Colletotrichum* sp. are minor diseases.

2.9.1.3 Citrus Diseases

Virus diseases are considered to be the most dangerous disease on citrus but none of these are yet confirmed in Barbados. The confirmed diseased of citrus are all of fungal origin. Hunger signs or nutritional deficiency symptoms are very common.

Major citrus diseased and causal agents are:

Diseases		Causal Organisms
Fruit Diseases:	Anthracnose	*Glomerella* sp.
	Melanose	*Diaporthe citri*
	Fruit Rot	*Pennicillium* sp.
Stem and Leaf Diseases:	Wither Tip	*Colletotrichum* sp.
	Scab	*Elsinoe fawcetti*
	Stem End Rot	*Diplodia* sp.
	Greasy Spot	*Mycosphaerella* sp.
	Some Nutritional Deficiency	

Seedling Diseases:	Damping Off	*Phytophthora* sp.
	Seedling Tip Blight	*Phytophthora* sp.

Minor diseases of citrus and or those with low occurence are: scab or fruit, sooty mold and some of the hunger signs.

2.9.1.4 Papaya Diseases

Over the past few years papaya production suffered a set-back because of root and collar rot, mosaic-like symptoms, and bunchy top disease. Postharvest fruit rot had occured significantly in a number of varieties and remains the major postharvest problem.

The major diseased and causal agents of papaya are:

Diseases		Causal agent
Fungus Diseases:	Anthracnose	*Colletotrichum* sp.
	Fruit Rot	*Colletotrichum* sp.
	Root Rot	*Phytophthora* sp.
Mycplasma:	Bunchy Top	MLO
Virus Diseases:	Mosaic)	
	Distortion)	Suspected
	Ring Spot)	
Hunger:	Generalised Chlorosis	Lime induced

Physiological:	Shoe string-like manifestation	Herbicide damage
	Leathery and rolling of leaves.	

Other diseases of papaya with low occurence are mildew (*oiduim* sp.), sooty mold, target spot (*Cercospora* sp.) and micro nutrient deficiency symptoms.

2.9.1.5 Cherries Diseases

Apart from sooty mold there are no other reported pathological conditions causing problems on cherries.

2.9.1.6 Annonas

This group of fruits are afflicted by only a few diseased of which the major one is anthracnose (*Colletotrichium annonicola*).

2.9.2 Control Strategy for Diseases

The strategy employed in controlling the major diseases in Barbados stress the integrated approach utilizing a three-pronged attack. viz. legislation, horticultural and agronomic manipulations and direct treatment.

2.9.2.1 Virus and Virus-like Diseases and Mycoplasma

These diseases are more important in citrus and papaya because they have not been found in any of the other fruit crops in Barbados. The control methods are:

- Quarantine Programs
- Insect Control - Many viruses and Mycoplasma are insect transmitted. The control of insect vectors is expensive and the effects are very temporary.

2.9.2.2 Apomitic Embryony

Although the operation aspect of this process is not done in Barbados, the results are applied to control virus spread especially in the introduction of new clones.

Nucellar embryos are those apomitic embryos that develop from the nucellus. The main characteristic is that they are true to type and also virus-free since viruses do not generally develop in very young meristematic tissues and seed transmission is very rare.

2.9.2.3 Meristem Culture

This is used in controlling papaya virus diseases but here again the mechanics of this technique does not take place here in Barbados, but the results are widely accepted.

The cultivars of papaya introduced to Barbados that are tolerant to one or more of the viruses at sometime, underwent this process.

2.9.2.4 Selection and Breeding

This program is currently being used to find cultivars tolerant to the virus and virus-like diseases of the papaya. Although the process is slow this program is expected to be a continuous one so that the effects of

these pathogens can be reduced to a minimum.

2.9.2.5 Resistant Rootstock

The establishment of a budwood registration and certification program to avoid or reduce the problem of virus and virus-like diseases of citrus, is currently being used in Barbados.

Through this program all the different methods of control and prevention are combined with the diagnostic methods for virus and virus-like diseases.

2.9.2.6 Fungus Diseases

Fungal diseases of fruit crops are controlled by application of good agronomic and horticultural practices coupled with use of pesticides.

The strategies employed are:

- The national Fruit Tree Spraying Program. (This is operated by the Plant Pathology Unit)

- Application of techniques of circumvent phytophthora root rot in avocado. (Through this technique vegetative propagation is being tried).

- Hot water treatments - This is being examined to determine the various temperatures and durations of exposure for certain fruits for controlling some postharvest diseases.

- Plant disease diagnostic services - This program offers disease identification and diagnostic service to fruit tree growers and the research departments. This aids in early prevention and treatment protocols in the fruit crop programs.

The Plant Pathology Section complements the operations of plant quarantine by offering diagnostic services.

There is a vigil set up at the Ports of Entry to select certain citrus diseases entering. Prohibition has been declared on citrus fruits from Florida. This is to prevent the entry of citrus canker (*Xanthomonas* sp.). Also, citrus fruits from California carrying symptoms of Alteraria fruit spots are not allowed entry.

Constant monitoring of fruits from other Caribbean Islands for the presence of disease of quarantine significance are kept up.

2.9.2.7 Citrus Planting Material

These material are not allowed entry into Barbados.

2.9.2.8 Planting Material for Other Fruit Crops

These are allowed permit, at which time the source and status will be thoroughly checked against notifiable diseases.

2.9.2.9 Postharvest Diseases

The major post-harvest diseases afflicting fruits are mainly of fungal aetiology.

With respect to mangoes and papaya, *Colletotrichum* is frequently incriminated in aetiology and studies into the control by hot water treatment is being undertaken. The various crops affected by post-harvest diseases are:

Crop	Post-Harvest Diseases
Guava	Fruit Rot (*Colletotrichum* sp.)
	" " (*Rhizopus* sp.)
Papaya	Fruit Rot (*Colletotrichum* sp.)
Citrus	Fruit Rot (*Colletotrichum* sp.)
	" " (*Pennicillium* sp.)
Avocado	Fruit Rot (*Botryodiplodia* sp.)

Most of these maladies occuring in storage are directly due to poor selection of fruits and poor handling. These maladies are for most of the time brought over from the field and/or were present in subclinical form prior to harvest.

3. FRUIT CROP MARKETING

3.1 MARKETING ORGANIZATIONS

3.1.1 Barbados Marketing Corporation (BMC)

The Barbados Marketing Corporation (BMC) is a statutory body established in 1963 and charged with the duty of improving the growing and marketing of produce. The BMC's is not currently a major force in the market since for most crops it handles less than 10% of total output.

However it must be noted that in the extra-regional marketing of Barbados Cherry it has been done through this Corporation.

3.1.2 Agricultural Commodity Trading Co. (ACTCO)

This organization is the marketing arm of the Barbados Agricultural Society and over the past four years, has been active in purchasing and distributing non-sugar commodities. This organization has also been an important channel for some produce especially breadfruit.

3.2 MARKETING CHANNELS

Apart from the very large part of fruit which goes directly from producer to the consumer, the marketing system consist of the following channels:

- Hawkers

  The hawkers (or huskers) market with an estimated share of 40% of the fruit production. Most hawkers buy for cash at the farmgate and market the fruit personally. Many hawkers also harvest the fruit themselves.

- Wholesalers

  This group of small scale middlemen are especially active in the hotel and restaurant trade and usually operate out of a small van. The wholesalers are also involved in the fruit import trade.

- Supermarkets

  Normally the supermarkets buy directly from the producers but only the larger supermarkets out of the total of about 150 establishments sell fruit on a significant scale.

- Hotel and Restaurant

  Some of the local production is consumed by tourist. In addition, some visiting cruise ships are also supplied with fresh fruit.

4. HUMAN RESOURCES

The central point of the fruit tree production activity is the Soil Conservation Unit at Haggatts in St. Andrew. This unit is part of the Ministry of Agriculture and Natural Resources.

The programme is headed by an Agronomist along with a Senior Agricultural Assistant. Technical support is given by the IICA fruit specialist. More recently an Agriculture Assistant has been added to the program. This staff will form the technical "back bone" of a Fruit Development Unit which is now being organized to take the programme into the future.

This staff works in collaboration with two Entomologists and one Pathologist in dealing with pest and disease problems. In addition, there are greenhouse attendants and nursery men.

5. GOVERNMENT POLICY & STRATEGY FOR FRUIT DEVELOPMENT

The objectives for the fruits subsectors are as follows:

- To encourage more extensive commercial fruit production.

- To increase the consumption of locally produced fruits.

- To improve production efficiency in the fruit industry.

6. STRATEGY

The fruit programme will focus on the following fruits§;

- Citrus (limes, grapefruit, orange*)
- Guavas
- Mangoes
- Avocado
- Passion fruit
- Paw paw
- Cherries
- Breadfruit

Emphasis will be on improving the quality of planting material to be made available to the industry. In this connection nursery facilities will be expanded and upgraded. Also screening of new varieties will be intensified with a view to identifying those which are best adapted to local conditions.

Other aspects of strategy are briefly:

- Introduction of projects to encourage greater consumption through nutritional institutions and use of mass media.

- Development of more organised marketing and distribution systems.

- Investigation and exploitation of export markets, especially for mango, cherry, breadfruit and avocado.

*Oranges where suitable

- Development of processing facilities.

7. ONGOING AND PROPOSED PROJECTS

7.1 ONGOING

The following is a brief description of ongoing projects:

7.1.1 Fruit Crop Development Project

This project is set up to support the development of fruit crop production in Barbados. More specifically, the objective is to overcome identified limiting problems affecting fruit crops in Barbados through:

- Introduction of imported fruit species and cultivars.
- Selection of outstanding local fruit species.
- Increased quality and quantity of nursery plants.
- Introduction of new techniques, practices and methods of propagation.
- Inservice training of local personnel involved in fruit tree programm (at various levels).

Agencies involved: MANR, IICA, and Barbados Agricultural Development Corporation (BADC).

7.1.2 Development of the Back River Valley

This project is primarily a conservation activity. However, fruit trees are grown on the more suitable areas of the project locations.

Agencies involved: MANR, IICA, and European Development Fund (EDF).

7.1.3 Scotland District Development Project

This project aims mainly at soil conservation. However, the project involves research on suitability of various fruit trees in the Scotland District.

Agencies involved: MANR, Inter-American Development Bank (IDB).

7.1.4 Barbados Cherry Project

Within this project the acreages of cherry tree will be expanded at least 100 acres and established orchards rehabilitated.

Agencies involved: BADC and MANR.

7.2 PROPOSED

The following is a brief description of the proposed project:

7.2.1 National Fruit Orchard Project

This involves the establishment of orchards on public and private lands. These will serve as demonstration units to farmers and will also be used for research purposes.

Within the project there will also be strengthening of services not available to the fruit industry.

Agencies involved: BADC, MANR, and Barbados National Bank (BNB).

COUNTRY PAPER - GRENADA

by
Paul R. Graham
Plant Protection/Quarantine Officer
Pest Management Unit, Ministry of Agriculture

1. INTRODUCTION

1.1 COUNTRY DESCRIPTION

The country of Grenada, situated at approximately 12°N latitude and 61°W longitude at the southern end of the Windward Islands chain, consists of the main island Grenada 120 sq. miles (305 square kilometers) and two small islands Carriacou and Petit Martinique with a total land area of 133 square miles (342 square kilometers/34,200 hectares). Like most of the other islands in the chain, Grenada is volcanic in origin and blessed with fertile soil and lush vegetation. Its terrain, characterized in numerous sources as "hilly", is a further legacy of its volcanic origin.

While the total land area of Grenada is estimated to be some 84,000 acres (34,000 hectares), only 22,000 acres (9,000 hectares) have a slope of less than 20 degrees. The amount of flat land is negligible. Except in the eastern and southern coastal areas where there are some flat lands, the rugged topography of the country inhibits the utilization of mechanization to facilitate modern agronomic practices.

1.2 AGRICULTURAL SECTOR

Agriculture is a central feature of Grendian society and plays a leading role in the country's economy. An important source of income, export earnings, and employment, the agricultural sector contributes about EC$95 million (US$35 million) or 25% of GDP. The

four major crops traditionally associated with Grenada's agriculture - cocoa, bananas, nutmegs and mace - account for 75% of this figure. The other 25% comes from other fruits and spices, vegetables, sugarcane, root crops and livestock products.

1.3 POPULATION AND EMPLOYMENT

Grenada's population hovers just under 100,000, with a relatively high density rate of 270 persons per km^2. The agricultural labour force is estimated to be some 12,500 workers, about one-third of the country's labour force. Of the 8,200 farm owners, 48% are full-time farmers. About one-third of the part-time farmers also work as hired help on other farms.

Despite high unemployment, especially in more urban areas, farmers complain of difficulties in hiring workers, especially during the peak harvesting season. Generally, there is the tendency among youths to move away from the land because of the low wages offered for agricultural products generally.

1.4 CLIMATE

Grenada is humid and tropical. Average annual rainfall ranges from 1270 mm (50 inches) in the coastal areas to over 4200 mm (165 inches) in the more mountainous interior. A year-round temperature of 25 - 30°C (78-87°F) implies a climate generally conducive and favourable for agricultural activities. In common with most Caribbean islands, Grenada has two seasons, dry (January to May) and wet/rainy (June to December). During the dry season, many areas of the island experience a moisture deficit which can inhibit agricultural production. Heavy rainfall, too, has its drawbacks; combined with high winds, it can contribute to soil erosion and property damage. Except in hurricane conditions (Janet, 1955 and/or Allen 1978), this has not been a problem however. Lack of moisture in the dry season remains a more serious concern.

1.5 ECOLOGY

In terms of soil conservation and ecology, fruit trees provide suitable protection for slopes. Not surprisingly, the Grenadian farmer has traditionally perceived fruit tree crops as being useful for windbreaks and for interplanting with the traditional export crops especially cocoa and bananas.

1.6 IMPORTANCE OF FRUIT SUBSECTORS

The climate and soil of Grenada are will suited to a wide range of tropical fruit crops, including avocado, mango, soursop, pawpaw, golden apple and guava which presently occupy an approximate acreage of 2310 acres, 5% of the total land area of the country. Many crops of different cultivars are scattered around the island, with one to several trees growing in one or more fragments of a holding. All fruit trees are planted in mixed stands and there are no commercial orchards. Large acreages of pure stand fruit trees are nonexistent though.

In 1982 the F.O.B. value of exports of fresh, semi-processed and processed agricultural products was EC$36.6M or 73% of the country's total exports; fruits and vegetables account for 12% of this.

2. COMMERCIALLY IMPORTANT SPECIES AND VARIETIES

Many species have traditionally been planted on a small scale and are sometimes sold in local markets or exported to Trinidad; however, they consist mainly of inferior cultivars. The recent development of cultivars more readily accepted in international markets presents new opportunities to enter off-season export markets. Avocado and mango appear the most promising in this regard although opportunities exist as well to sell off-season guava, pawpaw, golden apple and soursop in nearby markets.

Better yields and fruit quality, combined with early bearing and appropriate seasonality of harvest in relation to market demands could be obtained by planting modern cultivars, by using improved agronomic practices and by giving better attention to disease and pest control.

Pest and disease control in fruit tree crops has been negligible as fruits of these trees are largely for home assumption. Only the excess is sold or perhaps given away. Investment in pest and disease control measures for "backyard" plantings is not considered economic.

2.1 ACREAGE AND PRODUCTION FOR EACH CROP

Because fruit trees are grown mainly by small farmers for home use, and due to their establishment as windbreaks, or scattered on holdings, it it almost impossible to give an accurate count of the area under each specie of fruit. In addition, because the cultivated cultivars are so low producing, yields have not been monitored. It is a result of these factors, that the proposed Agricultural Rehabilitation and Diversification Project envisions the establishment of 144 hectares of fruit trees viz:- avocados, mangoes, and other miscellaneous fruits like golden and sugar apple, guava, pawpaw, soursop, tamarind and others. See Table 1 on fruit crop production for details.

It is envisaged that pure stands would be established using improved cultivars suitable for the export market. Avocado and miscellaneous fruit trees would start yielding three years after planting, reaching full commercial production on the fifth year. Mango would start production about the same period after planting but will not reach full maturity until the sixth year after establishment. Expected yields are:

Avocados	4000 kg/ha
Mangoes	3500 kg/ha
Miscellaneous fruits	4500 kg/ha

2.2 PRODUCTION SYSTEM

There is no planned system of production of fruit trees in Grenada. Farmers may, by choice, have one or several trees growing on fragments of land. Pure stands are non-existent except in instances where up to half an acre of pawpaw have been reported. In this case, pesticides are applied, but in the case of other crops this scarcely happens. Pest and disease control is incidental and occurs as the need arises.

Production begins in the second year for pawpaw and maybe three years later for mango if they are not treated. Fruits from the latter are mainly for home consumption and in some cases the excess is sold. See Table 1, fruit crop production, on which spacing seasonality, production, location and planting material suppliers are outlined.

TABLE 1. Fruit crop production by species, seasonality, location, acreage, and suppliers.

CROP	SEASONALITY	SPACING	LOCATION OF PRODUCTION	AREA IN WHICH THEY ARE TO BE GROWN	PROPOSED ACREAGE (1986)	SUPPLIERS (Plants)	ACRES/YEAR
Sappodilla	Sept.-June	12' x 12'	South, Southeast and central			Mirabeau	NA
Plums	Sept.-June	20' x 20'	South and South-east			Mirabeau	NA
Passion Fruit	July-Dec.	10' x 15'	Islandwide		100	Mirabeau	20
Mango	Sept.-June	30' x 30'	Islandwide			Mirabeau	NA
Papaya	Year round	10' x 10'	Islandwide		200	Mirabeau	40
Tamarind	Sept.-June	30' x 30'	South and East		100	Mirabeau	20
Sugar Apple	Sept.-June	15' x 15'	South and East		200	Mirabeau	40
Cinnamon	July-Dec.	8' x 8'	East and South-east			Mirabeau	NA
Guava	July-Dec.	18' x 18'	Central		135	Mirabeau	NA
Golden Apple	Sept.-June	30' x 30'	South and South-east			Mirabeau	NA
Sour-sop	Year round	12' x 12'	South and East		100	Mirabeau	20
Avocado	July-Dec.	22' x 22'	Islandwide		1000	Mirabeau	200
Cashew	Sept.-June	25' x 25'	Islandwide		100	Mirabeau	20
Kola nut	Year round	20' x 20'	Islandwide			Mirabeau	NA
Mamie Apple	Sept.-June	15' x 15'	Central			Mirabeau	NA
West Indian Cherry	Sept.-June	16' x 16'	South				

3. PESTS AND DISEASES

3.1 MAJOR PESTS

The major pests that warrant control are:

- Thrips
- Scales
- Whiteflies for food crops
- Mites
- Aphids

and Coreid bugs on citrus. Two major diseases of fruits are Sooty mold and anthracnose, both of which manifest themselves in most instances when the fruit is already harvested. See Table 2 below for major pests by crop.

TABLE 2. Major pest infesting fruits in Grenada by crops and pests.

Fruit	Pest
Avocado	*Selenothrips rubocinctus*
Guava	*S. rubrocincutus*
Pawpaw	*Corignothrips Stenopterus* *Empoasca* spp.
Mango	*Chalacolepidius wren* *S. rubrocinctus*
Pineapple	*Cholus spinipes* *Dysmicoccus brevipes*
Citrus	*Aspidiotus destructor* *Diaprepes famelieus* *Kerya montserratensis* *Malagus caribbeanus* *Saisettia oleae* *Taeniotes amozonum* *Xylotes* spp

3.2 CONTROL STRATEGY

While Grenadians are still aware of the adverse effects of pesticides on the environment, the desire for a higher level of production of high grade agricultural products, on the export market especially, has driven the Ministry of Agriculture to formulate a pesticide control board to suggest practices for pest control. This organization has placed special emphasis on:

- Exclusion through plant quarantine.

- Improvement of the level of cultural practices, eg establishing shade trees, drain clearing and the use of lime to increase soil PH.

- The implementation of an insecticide spray programme to coincide with the life cycle of insects and the physioiological development of trees.

- Use of resistant cultivars.

The re-organised Science and Technology Council is in this connection mandate to monitor and make recommendations on all aspects of pest and disease management. As far as development is concerned, our system is still weak. We suffer from lack of trained personnel and facilities necessary to implement:

- An efficient quarantine system as our first line of defense against exotic pests and diseases.

- Pest spray control programmes especially against fruit flies.

- Other areas of concern, e.g ways of dealing with any chance introduction of Africanised honey bee, citrus canker or Khapra beetle.

At the moment CARDI and IICA provide valued assistance to the Government of Grenada in advice on Pests Management problems. Both institutions provide training opportunities for middle and lower management personnel in crop protection.

4. PLANT QUARANTINE ASPECTS

Although Grenada is not known to be infested with major quarantine pests and diseases of fruit e.g. Mediterranean fruit fly, Oriental fruit fly, Mexican fruit fly, West Indian fruit fly, avocado seed borer and Citrus Canker, Grenada is unfortunately placed in the general group for quarantine reasons, because it is situated among islands which are infested by the exotic pests.

The lack of adequate trained personnel to carry out surveys, detection and control measures is also a serious constraint in the production and export of fruits.

5. POSTHARVEST

The major problems in postharvest handling of fruits that warrant attention are outlined below:

- Most farmers who handle and select fruit for the market are not educated sufficiently. As a result fruits are either battered to an extend before they get to the final consumer or substandard fruit are sent - a violation of the quality control standard of most importing countries.

- Fruit are still packaged in the traditional basket and placed onto any compartment of a ship found suitable. In the process, substantial bruises and salt water treatment disfigure the fruit, hence the reason why fruits look different in all aspects between Grenada and Trinidad.
  For the local market however, more care is taken since the

physical appearance determines demand and price, all other things remaining constant.

- Lack of expertise in quality control means that any fruit thought presentable enough can be sent to market.

6. MARKETING

The main marketing organization is the Marketing and National Importing Board (MNIB) which is not logistically well-organised for purchasing from small farmers throughout the country. No organised channels for cold storage trucks to collect farmers produce mean fruits reach storage in poor condition in some cases.

Most fruits are sold locally, the rest is exported to Trinidad and Tobago through hucksters. Until recently small quantities were shipped to the U.K. Good market potential is documented in U.S.A., Canada and Europe for avocado and mango, should the quality be high, the cultivar appropriate and the transportation arranged.

See Table 3 for estimated market demand for Grenadian fruits (metric tons for 1986.)

7. HUMAN RESOURCES

Like most developing countries Grenada lacks trained personnel in crop development. United Nations Development Programme and the Foods and Agricultural Organisation of the United Nations is assisting in a development programme viz:- propagation and distribution of specific fruit trees which includes mangoes, sapodillas etc.

The department has no nationally based entomologist or plant pathologist but benefits are derived from IICA's resident entomologist, Dr. C. Dominique and other regional pathologist to improve the technical capability of the Pest Management Unit which is now being organised by the Ministry of Agriculture.

TABLE 3. Total estimated market demand for Trinidad fruit exports in metric tons 1986 by species and country.

FRUIT	TRINIDAD	BARBADOS	UNITED KINGDOM
Avocado	342	269	10,033
Mango	70	268	4,186
Citrus	-	1,385	4,538
Other fruits	580	-	-

8. DEVELOPMENT PLANTS

Current Government policy on agriculture seeks not only to rehabilitate traditional export crops, but also to diversify the country's agriculture and to establish more non-traditional fruit crops, given the country's heavy dependence on food imports. e.g (In 1982 about EC$41.5, 13% more than the value of all exports). There is much need and room for expanding commercial fruit production in terms of volume, variety and quality. What has been basically a backyard farming operation must be expanded to a level of commercial production which can become an intergral part of the country's economy. The Ministry of Agriculture, is actually setting up a plant protection and quarantine programme and surveys for the monitoring and detection of exotic pests and diseases.

COUNTRY PAPER - DOMINICA

by

Hannah Claredon
Technical Officer Projects and Services,
Ministry of Agriculture, Dominica

1. INTRODUCTION

1.1 BACKGROUND - AGRICULTURE SECTOR IN DOMINICA

Dominica ia an English-speaking island in the eastern Caribbean Sea, measuring 289.8 sq. miles. Most of the country is dominated by mountainous ridges covered under rain forest. The terrain is very rugged with annual rainfall measuring from 100 - 300 inches towards the centre of the island.

The main crops being grown for export are bananas, citrus (limes and grapefruits) coconuts, cocoa, coffee, avocado, and mangoes. Bananas remain the most important crop.

The first 5 year agricultural sector plan was formulated in 1977. The main objectives of the plan were to:

- Improve quality of life of rural people
- To raise the standard of living of the entire population by increasing the level of economic activity thereby providing opportunity for renumerative employment.
- To provide greater economic flexibility by diversification of agriculture.

The major priorities identified by the plan were agro-industrial development, import-substitution, and dietary improvement. The main constraints to agricultural development are:

- Agricultural incomes have not been harnessed to provide domestic investment funds.
- Lack of effective marketing organisation and processing facilities.
- Inadequate regional transport.
- Low labour productivity.
- Present land tenure system.
- Large number of small farmers.
- Scarcity of trained personnel.
- Dominica being essentially a price taker on the international market.
- Lack of proper agricultural services.

In light of these constraints, and the fact that dependency ratio of the population is so high, with a 35% of persons employed being involved in agriculture, the development goals seem to be very ambitious. In light of high level of disguised unemployment, and large number of small farmers, increasing labour productivity is an almost impossible task as the industrial sector is even less developed. To diversify, given the land distribution pattern, would result in smaller and smaller parcels of land devoted to a particular crop as the diversification would be taken on mainly by the smaller farmers.

Dominica's agricultural sector was dealt a serve blow by hurricane David in 1979. The banana industry was most severly affected. The banana industry has also been plagued by a leaf spot crisis in 1978 and still further by two other hurricanes, Frederick in 1979 and Allen in 1980. Increasing costs of inputs, fluctuating prices on the English market and the fluctuating value of the pound, also worsened the situation. The call to diversify is now stronger than before. The main areas are in tree crops, essential oil and spices.

2. FRUIT CROP PROUDCTION AND MARKETING

2.1 BANANA

2.1.1 Varieties: Robusta, Gain Cavendish

2.1.2. Seasonality:Year round

2.1.3 Gross Production:

No accurate figures are available giving Gross Domestic Production figures for bananas. However, in the post-hurricane David years (since 1980), production is estimated to be in the region of 35-45,000 tonnes per year.

2.1.4. Production System

Production systems vary from large acreages of pure stand to small plots with inter-cropping of a wide variety of other crops) eg. root crops, tree crops). "Field packing" systems and centralised "boxing plant" packing systems operate.

2.1.5 Marketing (see export figures attached: Table 1)

In 1984, 97.7% of banana exports were for the U.K. market, channeled through the Dominica Banana Marketing Corporation (DBMC). This is therefore the major marketing channel for bananas, and operates the entire system of boxing plants/field pack collection. Geest Industries have the sole right to purchase best grade bananas and they buy all the bananas destined for the U.K. at two delivery ports, one in Roseau and one in Portsmouth.

Of the 752 tons of bananas exported regionally* in 1984, approximately 33% were sent to each of Trinidad and Antigua.

Antigua has traditionally been a major outlet, while Trinidad has only recently begun to take Dominican bananas. The Trinidad trade is conducted by Farm to Market Ltd. and the Antigua trade is predominantly a huckster trade with much fruit being exported on the stem.

*The total volume of the regional trade in bananas for the whole year is approximately equal to the amount shipped on on average week to the U.K.

Table 1. Exports of bananas 1976 - 1984, by destination (tonnes)

DESTINATION	1976	1977	1978	1979	1980	1981	1982	1982	1984
EXTRA-REGIONAL	N/A	29833	36120	15473	7621	26944	27166	28837	31880
TOTAL TO REGION	759	525	896	487	460	378	312	468	752
GUADELOUPE	30	54	50	34	9	21	32	86	127
MARTINIQUE	-	-	-	-	-	1	1	1	1
ANTIGUA	195	209	328	215	256	263	157	158	241
TRINIDAD & TOBAGO	0	0	23	4	0	0	0	6	258
BARBADOS	105	52	69	4	7	2	4	100	25
USVI	221	91	152	50	30	11	9	31	38
DUTCH ANTILLES	2	7	12	1	20	54	74	61	42
MONTSERRAT	11	13	37	11	7	3	0	8	1
ST. KITTS & NEVIS	195	98	224	162	130	23	34	17	18
GRAND TOTAL	N/A	50362	37016	15960	8081	27322	27478	29305	32632

2.2 GRAPEFRUIT

2.2.1 Cultivars: "March Seedless", "Rudy Red", "Thompson"

2.2.2 Seasonality: Year round availability; best bulk of crop September-March.

2.2.3 Gross Production

Current estimates put gross production at between six to nine thousand tonnes per year. In addition, new plantings of Ruby Red fruit under the Tree Crop Diversification Programme (TCDP) (416 acres) are forecasted to produce 250 tonnes of fruit per year by 1987, and 1,720 tonnes per year by 1992 when trees are fully mature.

2.2.4 Production System

There is a wide range in orchard size, from 100 acres and over, down to a few trees. Much of the new planting under the TCDP is in small quantities of between ½ an acre to 5 acres (50 trees per acre).

2.2.5 Marketing (see export figures attached: Table 2)

Table 2 shows clearly how the pattern of grapefruit exporting has changes over the last few years. Whereas in 1982, the U.K. was the main outlet for Dominican grapefruit, by 1985 the position was completely different with the region taking most of the exports. In 1984, total exports of grapefruits were 2,246 tonnes, 31% went to the U.K. and 69% to the region. Of the 1,610 tonnes exported to the region, 81% was sent to Guadeloupe, 9% was sent to Barbados.

The U.k. trade and some of the Barbados trade is handled by the Co-operative Citrus Growers Association (CCGA) which operates a central pack-house in Roseau with facilities to wash, size grade, polish, wax and "degreen" fruit. The rest of the trade is predominantly handled by husksters. The entire Guadeloupe trade is huckster-controlled. Recently efforts have been made to penetrate the Canadian market by Farm to Market Ltd. "Rudy Red" grapefruit attracts a premium price in all markets.

Table 2. Exports of grapefruits 1976 - 1984, by destination (tonnes)

DESTINATION	1976	1977	1978	1979	1980	1981	1982	1983	1984
EXTRA-REGIONAL	N/A	1311	2537	234	822	676	1526	922	737
TOTAL TO REGION	375	791	947	772	556	848	1127	1562	1610
GUADELOUPE	211	402	560	578	393	669	936	1271	1300
MARTINIQUE	-	-	-	-	-	12	7	17	25
ANTIGUA	11	31	36	34	28	28	41	48	67
TRINIDAD & TOBAGO	0	0	0	0	0	2	0	14	26
BARBADOS	111	289	251	124	118	120	124	175	149
USVI	18	17	26	2	1	2	4	11	13
DUTCH ANTILLES	3	1	3	0	2	4	7	12	8
MONTSERRAT	6	14	38	8	3	3	4	8	10
ST. KITTS & NEVIS	13	12	25	22	9	7	4	7	4
GRAND TOTAL	N/A	2102	3484	1006	1378	1524	2653	2484	2346

2.3 ORANGES

2.3.1 Cultivars: Washington Navel, Valencia

2.3.2 Seasonality: Available August - January ; Main season September-November.

2.3.3 Gross Production

No accurate estimate available, but estimated to be in the range of two-three thousand tonnes per year. New plantings under the TCDP (total of 642 acres) of both W. Navel and Valencia are forecasted to produce an extra 369 tonnes per year by 1987 and 1,924 tonnes per year by 1992, when all plantings would be fully mature.

2.3.4 Production System

Mostly in small orchards. TCDP plantings are in the range of one half to five acres.

2.3.5 Marketing (See export figures attached: Table 3)

The cultivars of oranges grown in Dominica are not suitable for export to European or U.S. markets. Thus the region accounts for all exports. The CCGA handles very small volumes of oranges to Barbados, otherwise the orange trade is predominantly in the hands of hucksters. In 1984, a total of 514 tonnes of oranges were exported with Guadeloupe taking most (54%), followed by Antigua (17%), Barbados (11%) and Trinidad (Farm to Market) (7%).

Table 3. Exports of orange 1976 - 1984, by destination (tonnes)

DESTINATION	1976	1977	1978	1979	1980	1981	1982	1983	1984
EXTRA-REGIONAL	N/A	9	0	0	0	0	0	0	0
TOTAL TO REGION	552	451	724	146	132	307	345	526	514
GUADELOUPE	201	269	468	119	92	216	199	347	279
MARTINIQUE	-	-	-	-	-	4	1	3	18
ANTIGUA	29	31	33	15	21	24	34	69	87
TRINIDAD & TOBAGO	0	1	0	0	0	0	0	8	36
BARBADOS	251	128	178	8	11	49	96	66	57
USVI	26	6	12	1	1	2	4	10	12
DUTCH ANTILLES	2	1	0	0	2	7	7	8	18
MONTSERRAT	10	4	11	0	0	1	0	8	3
ST. KITTS & NEVIS	31	9	18	3	4	4	8	7	3
GRAND TOTAL	N/A	460	724	146	132	307	349	526	514

2.4 MANGOES

2.4.1 Cultivars: "Long", "Common" or "Kidney", "Julie"

2.4.2 Seasonality: April - September

2.4.3 Gross Production:

No estimate is available for total production of all types of mangoes. Estimates for present production of Julie and other "grafted" cultivars is in the range of 150 to 250 tonnes per year. TCDP plantings of grafted mangoes (mainly Juile) (total of 310 acres) are expected to lead to production of an additional 456 tonnes by 1987 and over 1,500 tonnes by 1992 when all trees are fully mature.

2.4.4 Production System:

Plantings are mainly in small orchards of ½ to 5 acres.

2.4.5 Marketing: (See export figures attached: Table 4)

Extra-regional exports of grafted mangoes totalled only two tonnes in 1984. This is primarily due to the fact that the Marketing Board stopped shipping mangoes, having shipped 19 tonnes in a series of semi-trial/semi-commercial shipments in the 1983 season. On the regional scene, exports have not yet recovered to pre-hurricane levels. The main outlets in 1984 were Guadeloupe, Antigua and Trinidad (Farm to Market shipments), while before the hurricane, Barbados and the U.S. Virgin Islands were major outlets.

Table 4. Exports of mango 1976 - 1984, by destination (tonnes)

DESTINATION	1976	1977	1978	1979	1980	1981	1982	1983	1984
EXTRA-REGIONAL	N/A	12	9	7	3	4	4	19	2
TOTAL TO REGION	163	197	163	88	44	22	94	58	152
GUADELOUPE	44	62	86	38	4	9	29	23	52
MARTINIQUE	-	-	-	-	-	0	1	0	0
ANTIGUA	13	12	19	17	24	5	28	11	34
TRINIDAD & TOBAGO	0	0	1	0	0	0	0	1	42
BARBADOS	22	60	19	6	0	1	3	3	5
USVI	67	58	26	5	1	5	9	11	14
DUTCH ANTILLES	1	0	2	2	1	1	23	6	2
MONTSERRAT	1	1	0	1	1	0	1	0	0
ST. KITTS & NEVIS	15	4	10	18	14	0	1	2	3
GRAND TOTAL	N/A	209	172	95	47	26	98	77	154

2.5 AVOCADO PEARS

2.5.1 Main Cultivars: "Local", "Dominica Selected", "Lula", "Tonnage", Senail 34 (around 12 grafted cultivars introduced in TCDP)

2.5.2 Seasonality: June - October

2.5.3 Gross Production:

No accurate estimates are available of total production of avocados. Best estimates would give a figure of 150 to 200 tonnes. TCDP plantings (mainly "Lula") (total of 105 acres) are expected to lead to additional production of 117 tonnes by 1987 and 183 tonnes by 1990, when all trees are fully mature.

2.5.4 Production System:

Most trees are in small orchards one half to three acres.

2.5.5 Marketing: (See export figures attached: Table 5)

Export volumes in 1984 totalled 90 tonnes, higher than in any year of the period 1976 -1984. However, this is still a very small amount. Guadeloupe and Antigua have been the major recipients.

Table 5. Exports of avocado 1976 - 1984, by destination (tonnes)

DESTINATION	1976	1977	1978	1979	1980	1981	1982	1983	1984
EXTRA-REGIONAL	N/A	1	0	0	0	0	1	3	12
TOTAL TO REGION	61	58	61	19	6	29	27	64	78
GUADELOUPE	26	38	32	11	1	18	15	44	29
MARTINIQUE	-	-	-	-	-	0	1	1	1
ANTIGUA	10	8	13	4	4	7	8	14	25
TRINIDAD & TOBAGO	0	0	1	0	0	0	0	0	4
BARBADOS	2	1	1	1	0	0	1	1	1
USVI	16	6	6	1	0	2	0	3	10
DUTCH ANTILLES	0	0	0	0	0	1	2	1	7
MONTSERRAT	1	0	0	0	0	0	0	0	0
ST. KITTS & NEVIS	5	4	9	2	1	0	1	1	1
GRAND TOTAL	N/A	59	61	19	6	29	28	67	90

3. PEST AND DISEASES - PRE AND POST HARVEST

The major pests and diseases and control strategy are given in table 6.

Table 6. Major pest and disease affecting fruit crop in Dominica

CROPS	Pests and Diseases		CONTROL STRATEGY
	Pre Harvest	Post Harvest	
BANANA	Sigotoka (*Mycospharella musicola*)	Anthracnose (*Colletotrichum musae*)	Spary programme for control (acrid and ground)
	Banana Borers (*Cosmopolites* spp)		Soil nematicide/insecticide (Furadon, Mocap, vydate).
	Thrips		Blue diathane sleeving of branches for insect protection.
	Beetle (*Zacnopus* sp)		Lacnopus control programe to start.
	Nematodes		
MANGO		Anthrancose (*Colletotrichum gloeosporioides*)	Experimental - pre-harvest application of fungicides (Benlate, Cupravit)
GRAPEFRUIT	Greasy Spot (*Mycosphaerella citri*)		Pre harvest application of fungicides, Malathoin, Albolineum)

TABLE 6. (Continued)

CROPS	Pests and Diseases		CONTROL STRATEGY
	Pre Harvest	Post Harvest	
	Melanose (*Diaporthe citri*)	Melanose	
	Scab (*Fawcettii elsinoe*)	Scab	Post harvest treatment of fruits for export.
	(Limes) Wither-tip (*Colletotrichum gleosporioides*)	Wither-tip (Limes)	Experimental - citrus weevil control using soil insecticides (Lorsban G. Furadan).
	Brown rot (*Phytopthora* spp)	Brown rot	
	Sooty Mould	Green Mould (*Pencillium digitatum*)	Root stock evaluation for scion acceptability (disease resistance)
	Rust Mite (*Phyllocoptruts* spp)	Fruit flies (*A. obliqua*)	
	Mealy Bug (*Planococcus* sp)		
	Cottony Cushion Scale (*Icerya purchasi*)		
	Aphids (*Aphids* sp. *Toxopters* sp.)		
	Citrus Weevil (*Diaprepes* spp)		

Table 6 (continued)

CROPS	Pests and Diseases		CONTROL STRATEGY
	Pre Harvest	Post Harvest	
AVOCADO	Root rot (*Pyhtopthora Cinnamomi*)	Anthracnose (*Colletotrichum gloesporioides*	Ad hoc. pest and disease control
	Scab (*Sphaceloma purea*)		
	Spot blotch (*Cercospora purpurae*)		
	Mite		

4. PLANT QUARANTINE ASPECTS

4.1 PESTS AS CONSTRAINTS IN THE EXPORT OF FRUITS

4.1.1	Bananas	-	Slugs and snails
4.1.2	Citrus	-	fruit fly
4.1.3	Avocado	-	
4.1.4	Mango	-	fruit fly *Anastepha Obliqua*
			fruit piercing moth

4.2 DISEASE AS A CONSTRAINT IN EXPORTS OF FRUITS

4.2.1	Bananas	-	*Anthracnose colletotrichum*
4.2.2	Citrus	-	Brown Rot
			Scab *Elsinoe fawcetti*
4.2.3	Avocado	-	Anthracnose
4.2.4	Mango	-	Anthracnose

5. POST HARVEST PROBLEMS

Apart from pest and diseased which affect fruits post harvest, that are other factors which seriously limit the export of the fruits: conditions under which fruits are harvested; manner in which handled; quality of packaging conditions; storage temperature carbon dioxide ethlyene levels; condition of transportation both locally and intra-regionally; lack of information on critical maturity indices which seriously affect fruit quality; conflict in taste of market and taste of farmers.

6. HUMAN RESOURCES

Persons who are directly involved in fruit crop development are as follows:

Agronomist	8 (2 D.B.M.C.) Division of Agriculture
Enotomologist	2 - T.D.R.I., Winban

Plant Pathologist	4 - C.A.R.D.I., I.I.C.A., WINBAN, Division of Agriculture.
Plant Quarantine Inspectors	4 - Division of Agriculture
Crop Protection Specialist	1 - D.B.M.C.

7. DEVELOPMENT PLANS

The major policy of the government is to diversify agriculture and to become more self-sufficient in food production.

The major strategy is through small farm development and expansion of the market base. On-going projects are as follows:

- Tree Crop Development - avocado, mango, citrus, coffee
- Orchard Pest Management - citrus, avocado, mango
- Post Harvest Technology - avocado, mango, packaging

Proposed: Tropical Fruits and Spices project.

COUNTRY PAPER - GUYANA

by

Janice Gittens
Plant Protection Officer
Ministry of Agriculture

1. INTRODUCTION

In Guyana, fruit crop production has had a chequered history. Patterns of social, political and economic development have influenced the relative importance of perennial crops (fruit crops). Research activities have been devoted almost exclusively to the two (2) main crops - sugar and rice, thus very little work has been done on fruit crops in terms of the agronomy and far less has been done on the plant protection aspect.

Guyana's agricultural thrust today is geared towards diversification away from rice and sugar. Research activities now include other crops e.g., fruit crops. The importance of fruit to our diet has long been recognised and with the reduced importation of non-tropical fruits (apples, grapes etc.), there is movement towards increased production of local fruits. Attempts to increase production have created a greater awareness of the pest and disease problems associated with fruit crop production.

There is also a new approach towards the increased commercialisation of a wider range of tropical crops especially the lesser utilized tropical fruits e.g. carambola *Averrhoa carambola* (L).

This new and optimistic trend as regards the potential of lesser known tropical fruits, augurs well for the future of the crop production programme. However, our limited knowledge and experience of the pests and diseases of these crops would necessitate more in-depth studies in the management of fruit production.

With advanced technology, improved transport and refrigeration facilities, there are lucrative overseas markets for locally grown fruits and these avenues must be further exploited. But first it must be ensured that the fruits are not only of the highest quality but free of pest and diseases. Additionally, attempts to improve both production and productivity by looking seriously at our pest and disease problems must be made.

2. SYSTEM OF CULTIVATION

Guyana has a wide variety of fruit types. The most important are citrus *Citrus* sp, pineapples *Ananas comosus* L. Merr, bananas *Musa* sp, mangoes *Mangifera indica* L., guavas *Psidium guajava* L, avocados *Persea americana* Mill. and paw paw *Carica Papaya* (see appendix I). Except for citrus, pineapples and bananas, fruit plants are not cultivated as pure standards. Farmers plant along dams bordering trenches and canals and interplant with other crops. In most cases the trees are planted at random, since farmers do not plant for organised markets.

3. PEST AND DISEASES ASSOCIATED WITH FRUIT CROP PROTECTION

Pests and diseases are problems in the production of citrus, pineapples, bananas, mangoes, guavas, avocados and paw paws, and are among those factors which contributed to low productivity and the decline in fruit production. Total fruit production has declined from 1,488,789 kgs in 1975, to 446,636.7kgs in 1981 - a decline in production of approximately 70%. It is estimated that pests and diseases account for 15% of this fall in production.

3.1 CITRUS, *Citrus* spp

Citrus is the most important fruit crop grown in Guyana. There are a few well-organised citrus farms covering an area of approximately 1,445 hectares, scattered over the ten (10) regions of the country. Fruit production declined from 608,345 million pounds in 1973 to 341,698 million pounds. Apart from

socio-economic factors, pests and diseases contributed to the decline of the enterprise.

3.1.1 Major Pests Affecting Citrus

Major producing citrus areas include the Northwest Region and the important pests affecting the crop are:

3.1.1.1 Citrus Whitefly - *Dialeurodes citrifoli*

The citrus whitefly causes injury to the foliage resulting in leaf fall and sometimes fruit fall. The adults suck sap from the trees and secrete large amounts of honey dew on which the sooty mould fungus grows.

Control of *D. citrifoli* is obtained by spraying the photosynthetic activity of the plant with 0.15% carbaryl W.P. or 0.05% dimethoate.

3.1.1.2 Tropical citrus aphid: *Toxoptera citriadus*

The black aphid also exudes a sweet liquid called the honey dew. When the honey dew accumulates, the sooty mould fungus also appears. The activity of the citrus black aphid also results in leaf fall, but more important is the fact that the pest is the vector of the dangerous tristeza virus.

Control measures used for the black aphid are similar to those for the white fly.

3.1.1.3 The Acoushi or Leaf Cutting Ants: *Atta* and *Acromyrmex* spp

The leaf cutting ants are the most destructive pests of citrus in Guyana and are found wherever citrus is cultivated. These ants defoliate trees and carry the leaves to their nest. Crop losses due to this pest can be as high as 100%, especially in young citrus orchards. This devastating effect is particularly noticeable in forested areas recently cleared for establishing citrus orchards. It is so because the equilibrium has been disturbed and the planted crop provides a more succulent material for the pest than what was there before.

A variety of toxic chemicals applied as dust, vapour or smoke have been used in controlling the ants. Among these chemicals were aldrin, BHC, carbon bisulphide and dieldrin. The chemicals were actually applied to the nest and as such, finding the nest proved an important factor in the control.

Locating the nest can be extremely difficult at times especially in orchards surrounded by forests. Methods used to apply the chemicals were dangerous and labour intensive and as a consequence the use of a poison bait has superseded the direct use of chemicals.

The use of the bait has increased the efficiency in control of the leaf cutting ants. The advantages of the toxic bait over general application by spraying or dusting are:

- The active ingredient can be spread sparsely in the environment, leaving food for the pest.

- Bait requires less critical placement than non-persistent contact insecticides, so is often less expensive.

The bait in use either contains mirex, a slow acting stomach poison, or aldrin a contact insecticide. The techniques for baiting are, however, similar for both chemicals.

- Baits are scattered along the trail of nests and around feeding holes.
- Baits are not handled with bare hands.
- Wetting of the bait is avoided by covering the bait with bamboo troughs.

3.1.2 Major Diseases Affecting Citrus

In addition to pests, diseases also pose a problem to successful citrus production. Diseases of citrus may be caused by fungi, bacteria and viruses. Diseases peculiar to citrus cultivation include:

3.1.2.1 Citrus Scab: *Elsinoe fawcettii*

Citrus scab is most commonly seen on limes but incidences of the disease have been reported on oranges and grapefruit. Scab is of importance in the nursery and has retarded the growth of seedlings in some nurseries as much as 50%.

The disease can be controlled by the use of light shade (reducing dew formation) together with a copper spray - Cupravit, Kocide or Bordeaux.

3.1.2.2 Citrus *Tristeza*

A viral disease causes defoliation, die back of twigs and severe stunting of the entire tree. Losses due to this virus have not been extensive because strains of the virus which exist here are less virulent than those known to exist in some parts of the United States for example.

Except for biological tests done in the 1970's to determine the presence of the virus, no work has been attempted with respect to the control of the Tristeza virus. In citrus multiplication programmes budwood is selected from trees which appear to be disease free, and have good agronomic characteristics. It must be added that no foolproof local method of implementing any system of ascertaining whether the trees are in fact disease free, is available. There is, therefore, the possibility of disseminating the virus this way.

3.2 PINEAPPLES - *Ananas cosmosus* L. MERR

3.2.1 Major Pests Affecting Pineapples:

For commercially acceptable yields of pineapples to be obtained a number of noxious pests must be controlled. Notable among them are:

3.2.1.1 Pineapple Mealybug - Ant Complex - *Dysmicoccus brevipes. Cockerell, Soleopis* sp- and *Acaucomprmex* sp.

The ants tend the pineapple mealy bug on pineapples in sandy soils and cause heavy infestations. The mealy bug has been incriminated as a vector of

Saccharomyces sp. (Rai et al., 1977), the causal organism of gummosis of the pineapple fruit.

The ants make deep underground nests in pineapple fields for themselves and sand shelters for the mealybugs on leaf bases of the pineapple plants. They carry the mealybugs to the infloresence and also make sand shelters on young developing fruits.

The ants must be controlled when attempting to control the mealybug or control will fail. Direct control of the mealybug generally follows only after controlling the ants. Aldrin sprays are used for the ants followed by fenitrothion sprays for the mealybug. Disinfestation of the pineapple slips is also done. Slips are dipped in 0.01% Omethoate emulsion and are kept for two (2) days under cover (to prevent insecticide loss by rain action) before planting.

It is important to note that the pineapple mealybug *D. brevipes* infesting "pineapple plants on land" excluding parts of plants in trade, has been declearęd as 'Notifiable Pest', pursuant to plant protection laws of Guyana. Accordingly, the Chief Plant Protection Officer could give notice to pineapple growers to control the mealybugs within a specified time. If growers fail to comply, the government could undertake the control measure at the growers' cost.

3.2.2 The Major Disease of Pineapples:

The major disease of pineapple is:

3.2.2.1 Gummosis Rot - *Saccaromyces* sp.

In Guyana there is a very high incidence

of gummosis disease in fields on the Soesdyke/Linden Highway but it is less severe in other pineapple growing areas such as the Canals, West Bank Demerara.

External symptoms of gummosis consists of exudates of a brown gummy substance which occurs from any part of the fruit but is particularly frequent from the base and crown. Affected fruits lose flavour and texture.The disease becomes evident in the field but can develop on fruits while in storage and to a lesser extent while intransit. Losses of the pineapple crop due to gummosis rot during storage and intransit are estimated at 40% (McDonald and Muller, 1974).

A mealybug *Dysmicoccus brevipes* has been shown to be a vector of the disease (Rai, et al., 1977). 1977). Control of the gummosis rot involves:

- Efficient handling and packing during harvesting and while intransit prevents the disease to some extent.

- Good storage with efficient ventilation.

- Sodium hypochlorite dips at 0.5 and 1.0% concentrations of pineapples after harvesting.

- Spray with Fenithrothion for control of the mealy bug.

3.3 BANANAS - *Musa* sp.

Bananas (caven dish triploid) are grown extensively in Guyana, totalling some 1,126.3 hectares. Over the past thirteen (13) years there has been a significant decline in yields. In 1963 yields were 11,760 kgs per hectare whereas in 1973 yields were 4,188.8 kgs

per hectare, a reduction of 64.4% (Anon, 1980).

Predial larceny, pests and diseases were mainly responsible for the depressed production.

3.3.1 Major Pests of Bananas

3.3.1.1 Banana Root Weevil - *Cosmopolites sordidus*

The weevil exists whereever banana and plantains are grown on a large scale. In certain parts of the Northwest District, Essequibo and West Demerara losses due to this pest are quite severe.

Injury is caused by the larva feeding and tunnelling in base of the corm. The damage caused, is often increased by other insects and bacteria. The damage corm prevents effective nourishment of the plant and the leaves eventually wither and die. Healthy trees may topple due to damaged roots.

3.3.1.1.1 For the control of banana weevil the following is recommended:

- Sanitation - Since the banana weevil lives on plant debris it is essential to clear rotting vegetation and so reduce the areas suitable for harbouring the pest.

- Chemical control - There are three (3) methods of chemical control used in Guyana.

3.3.1.1.1.1 trapping

The adult weevil is known to be attracted to cut pieces of pseudostem. Traps are prepared by treating the surface of 45 cm long

pieces of pseudostem with 0.05% monocrotophos solution. The traps are placed (cut surface downwards) between the plants. The traps will attract and kill the adult root weevil for a ten (10) day period.

3.3.1.1.1.2 treatment of the planting material

The pared suckers are dipped in 4% monocrotophos emulsions and are stored for twenty four (24) hours to be protected from rain before planting. This treatment kills any eggs in the sucker and prevents infestation up to three (3) months after planting.

3.3.1.1.1.3 Field treatment of infested plants

About thirty (30) days after planting bananas in infested zones the plants are dusted or sometimes sprayed to protect them from weevil attack. The treatment is repeated at regular intervals, Aldrin sprays are most widely used.

3.3.1.2 Banana fruit Scarring Beetle - *Colaspis hypochlora*

The adult beetles feeds on almost all stages of the fruit resulting in surface wounds. This type of

damage does not extend to the edible portion of the fruit but reduces its market value. For control bunches are sprayed with 0.1% carbaryl.

3.3.2 Major Diseases of Bananas:

3.3.2.1 Moko Disease or Bacterial Wilt - *Pseudomonas solanacearum* E.F. Sm.

Moko disease. a very destructive disease, is found on plantains and on Cavendish bananas (AAA) in Guyana. This disease occurs in all banana growing areas.

The spread can be traced to the massive movement of planting material across the country during the past ten (10) years (McDonald, 1981).

This disease affects the stem, leaves and fruit. In severe infections the entire plant dies and falls . In instances where the disease is not severe, the plants produce small bunches of fruit which may have little or no market value.

Reduced production of bananas has been partially due to poor yields, death of plants and the abandonment of lands by farmers who have "bitter experiences" of losses (in some cases entire crop losses) due to moko disease (McDonald, 1981). Loss estimates show that the moko disease reduces yields by 10 - 40% (McDonald, undated).

All chemical control measures tried have proven unsatisfactory and the disease continues to plague all

areas including new lands where the disease was introduced with infected material. Ensuring that only disease-free planting material is used in establishing new cultivations is one means by which farmers 'battle' against the disease.

3.3.2.2 Nematode Rootrot *Radopholus similis*

Over the past two (2) decades, this single nematode species has replaced fusarium as the major banana root pathogen. This nematode causes root rot, black head disease (so named because of black lesions on the corms) and toppling over of the plant due to root damage.

The nematode is not widespread in the country. The significance of this organism is in terms of its potential damage on bananas in Guyana. Steps are being taken to have the nematode declared a notifiable disease pursuant to the Plant Protection laws of Guyana.

In areas where the nematodes occurs soil treatment at planting - 28 gms of furadan or Nemacur per corm is done. Field sanitation - removal and burning of affected plants - is also done. Farmers are also advised to use clean planting material as it is important not to introduce the disease into new cultivations.

3.4 MANGOES - *Mangifera indica* L.

At the moment there are no large scale commercial mango orchards in Guyana. Trees are scattered along the coastland and fruits are sold in local markets. It is estimated that the areas under cultivation is approximately 144.5 hectares. The estimated

yield is 363.6kg to 454.5 kg per hectare on 43 trees per hectare. (Baichoo, 1980).

3.4.1 Major pests of Mangoes

3.4.1.1 Fruit Flies - *Anestrepha* sp.

These flies affect mangoes and cause appreciable losses especially in the early, late and out of season crops.Spraying with rogor 40 is usually recommended to farmers.

3.5 GUAVAS - *Psidium guajava* L.

Guava has always been a popular fruit in Guyana. It is found growing in marginal lands and on swampy lands in the riverain areas. In addition to handling, transporting and packaging pests are problems which often result in the very poor quality fruit that reaches the market. There is a disease of guavas e.g. anthracnose, but fortunately it is not a major problem.

3.5.1 Major Pest of Guavas

3.5.1.1 Fruit flies - *Anestrepha* sp.

These are the worst pests of guava. The so-called worms in guava fruits are most often the larvae of the fruit fly. In certain areas e.g. Pomeroon River, infestations are so high that it is impossible to find a fruit that is free from infestation. Fruits are often reduced to a discoloured misshaped rotting mass totally unwholesome for market.

A reasonable amount of control is achieved by spraying with Sevin, at the on-set of fruit ripening.

4. RECOMMENDATIONS AND CONCLUSION

In a universally deepening food crisis, fruit crop production can promote the economic development developing countries. Guyana, with her declared policy of self-reliance in food is no exception. This short paper has, however, identified the need for a more positive and dynamic approach to the management of a potentially viable fruit crop industry, so that local needs would be met and the lucrative Caribbean markets captured. Regular supplies of a high quality fruit must be guaranteed, a condition which can result from orchards which are free of pests and diseases.

The Plant Quarantine service must be expanded to include an internal system and up-graded in order to operate at acceptable levels of efficiency. Relevant research activities should be vigourously pursued so that solutions may be found for current and potential pest and disease problems.

It must not be forgotten too, that the farmers in the field are the most important actors in this increased production process. The consistent and persistent education of these workers is therefore imperative. Effective systems of production ought to be put in place and several of the frustrating periods significantly reduced so that the required productivity would result.

It is recommended also that a record of the distribution of these pests and diseases as they relate to various areas across the country must be made and constantly reviewed. This will not only point to particular areas with specific difficulties but will go a long way towards the effective control of the spread of diseases.

It is against this background therefore that a seminar of this nature is both useful and timely.

BIBLIOGRAPHY

1. Guyana Ministry of Agriculture. Agricultural Marketing Statistics. 1975-1979; Vol. III. Georgetwon. 99p.

2. Baichoo, C.S. 1980. Country report on fruit crops production in Guyana. Paper presented at the Caribbean Workshop on Traditional and Potential Tree Crops (1978: Grenada). 24 p.

3 Bissessar, S. 1962. A revised list of diseases of economic plants in British Guiana. Georgetown, Guyana: Ministry of Agriculture. 22 p.

4. Brathwaite, Chelston W.D. 1981. The challenges for plant protection in the Caribbean in the 1980's and beyond. Key note address presented at the Meeting of the Society for Plant Protection in the Caribbean (1981: Jamaica). 171 p.

5. _____ 1981. Perspectives for Plant protection in the Caribbean in the 1980's. Address presented at the Plant Protection Course (1981: Guyana) 16 p.

6. _____ and Gene V. Pollard 1981. Urgent plant pest and disease problems in the Caribbean. Papers presented at the Meeting of the Society for Plant Protection in the Caribbean (1981: Jamaica) Port-of-Spain, T'dad: IICA. 206 p.

7. Crop and livestock statistics in Guyana: A compilation of existing data. 1980. Georgetown, Guyana: Ministry of Agriculture. 65 p.

8. McDonald, F.D. 1979. Gummosis associated with pineapple (ananas comosus (L) Merr) rot in storage. Paper presented at the Research Horizons in Agriculture, Guyana Seminar Series. 7 p.

9. Pattanjalidial. 1978. Status of citrus tristeza virus in Guyana. Mon Repos. Guyana. 81.

10. Pratt, Robert M. 1958. Florida guide to citrus insects disease and nutritional disorders in colour. Gainesville, Fla: Agricultural Experiment Station.

11. Rai, B.K. and A.K. Sinha. 1980. Pineapple: Chemical control of mealy bugs and associated ants in Guyana. pp41-45 in Journal of Economic Entomology 1980; Vol. 73, No. 1.

13. Weir, Colin Fruit tree crop production in the Caribbean region. 1982. Kingston, Jamaica: 149 p.

COUNTRY PAPER - St. Lucia

by
A. D. Auguste
Crop Protection Officer
Ministry of Agriculture

1. INTRODUCTION

St. Lucia is an island of 616 km^2 (238 sq. miles) and lies across latitude 13°, 50' North and longitude 61° West. The population is estimated at 127,000, the vast majority of whom are of African decent. The soils are of volcanic origin and the valleys are fertile. It's topography is mountainous with the major peaks rising to between 700 - 1000m. The rainfall ranges from 1200mm - 2400mm per year with the highest precipitation concentrated between July and December. The temperature range is 24 - 31°c.

The agricultural sector presently represents about 50 percent of the value of the total domestic exports. Bananas, being the major crop, contributed 94 percent of the agricultural exports in 1984. Meanwhile, the volume of other fresh agricultural produce exported for that year totalled 1856 tonnes, the major contributors being breadfruit, plantains and mangoes. Agriculture provides jobs for more than 40 percent of the Country's work force, a figure which has declined over the last 10 years with the shifting of labour from that sector towards industry.

The importance of the fruit sub-sector in St. Lucia is becoming more significant. Though accurate statistical data concerning that sub-sector is not presently readily available, 'Prix Produit' describes the export trade of these commodities as showing significant growth.

In 1985 citrus, sour sop and breadfruit showed increases in export over the same period in 1984, though mangoes showed a sharp decline. The same source describes the overall increase as being attributed to the diversification of markets along with the development of a broader base of export crops.

2. FRUIT CROP PRODUCTION

2.1 MANGO (*Mangifera indica*)

The two main commercial cultivars of mango are the 'Julie' and the 'Graham'. The Julie is a medium sized fruit of weight 227 - 230 grams (8 - 12 ounces) and is coloured green to yellow with some deeper red colouring when ripe. The pulp is yellow to orange, free of fibre, juicy, sweet, and surrounds a narrow stone. The fruit ripens quickly and so has only moderate shipping quality.

The Graham is much larger weighing 550 - 680 grams (16 - 20 ounces). When ripe, the skin colour is green to yellow with occasionally more orange colouring. The pulp is less juicy than Julie and is free of fibre.

The acreage under mangoes in St. Lucia has not yet been determined with any great degree of accuracy due to the large existence of numbers of disorganised plantings particularly of the more traditional cultivars such as Long and Palwee. The more organised Orchard Crop Diversification Project initiated since 1980 has established 250 acres of grafted mangoes, (i.e. Julie and Graham), and it is estimated that there is an additional 100 acre equivalent giving a total of approximately 350 acres.

Present production of fruit from grafted trees is in the region of 450 tons. So far in 1985, 300 tons have been exported. In 1984 the local market (hotels and Central Market) is estimated to have bought 100 tons of mangoes.

Mangoes are inter-cropped with a variety of banana and other fruit crops and benefit from improved husbandry since inputs are made available under the programme. These are established islandwide although they enjoy best production in sheltered and well-drained areas and require 700 - 1200 mm (30 - 50 ins) of

rainfall. Higher rainfall predisposes the crop to diseases, particularly anthracnose.

Mango production is concentrated in the period between April and September with June and July being peak months. With more traditional varieties however, the season tends to be more prolonged due to the variation exhibited between cultivars.

2.2 CITRUS (*Citrus* spp)

Production of this crop in St. Lucia is comprised of oranges, grapefruit, limes, tangerine, shaddock and ortanique.

The main cultivars of orange are the Washington Navel and Valencia. Washington Navel is an early maturing cultivar, best suited to the coolness of higher elevations and is suitable for utilization as a table orange. Valencia, on the other hand, is late-maturing and can tolerate higher temperatures than the previous mentioned variety and is better suited to juicing. There is also the Sour Orange which is used for preparation of marmalade as well as a source of root stock material for propagation.

The dominant grapefruit cultivars consist of the white types: the seedless Marsh grapefruit and the seeded Duncan. Lately the red flesh grapefruits have been introduced, the Ruby Red being more prominent over the Foster and Thompson.

Tangerines are of unknown origin having been produced from ungrafted seedlings. However the Dancy tangerine has been introduced into St. Lucia and its acreage will be expanded in the future.

The hybrids comprise the Minneola tangelo, (which is a cross between the Duncan grapefruit and the Dancy tangerine), and the Ortanique (cross between a tangerine and orange). These are

produced to a limited extent under the Orchard Crop Diversification Project.

Lime has been in existence in St. Lucia for a long time and has been of the West Indian type. Recently Tahiti seedless limes have been introduced under the O.C.D.P.

Citrus commands an acreage of about 1325. Of this grapefruit occupies the equivalent of 550 acres, 150 acres being planted in the red types and the remaining 400 acres in white flesh grapefruits. Oranges occupy about 600 acres and limes 100 acres. Other citrus species such as hybrids occupy probably about 75 acres.

Production of grapefruit stands currently at 400 tons but is expected to rise fourfold to about 1650 tons in 1995, mainly due to the newly planted trees coming to full bearing. Orange stands at 600 tons and is projected to rise to 1500 tons in the same period for the same reason. Production of limes is currently about 100 tons and so is the production of tangerines and the hybrids. These figures are projected by 1995 to increase to 200 and 150 tons respectively.

The citrus species can be found to bear almost year-round in St. Lucia though the main production period is between August and April. Tangerines come in first along with Washington Navel oranges, followed by grapefruits and mid-season oranges and lastly, late-bearing grapefruits, ortaniques and late-maturing Valencia oranges. These last are planted in higher areas where rainfall is not limiting and this crop also is inter-planted with other tree crops and bananas.

2.3 AVOCADO (*Persea americana*)

Many cultivars of this crop are found in St. Lucia. Most are of the West Indian race originating out of the lowlands of Central

America and characterised by medium to large fruit with smooth leathery skin. They are early maturing with large loose seeds within the seed cavity. Examples of these cultivars are Pollock, Simmonds, St. Croix and Francois. Lula and Booth have been introduced into St. Lucia, and also the Fuerte Avocado which is a cross between the Mexican and Guatemalan races.

The West Indian race along with some of the crosses e.g. lula, are grown in lowland areas where the annual rainfall is between 1500 - 2000 mm (60 - 80 inches) with a short dry period of about three (3) months. Low moisture and good drainage is necessary to avoid problems such as Root rot. Avocados are prone to strong wind damage as was demonstrated by Hurricane Allen in 1980 when substantial losses were incurred as a result.

The present acreage under avocados is estimated at 150 acres, 81 acres of which were established within the past five (5) years. This represents a current production of about 120 tons which is expected to rise significantly over the next few years (1995) to about 300 tons.

2.4 BREADFRIUT (*Artocarpus altilis*)

This crop represents probably one of the most understudied of the fruit crops of significance in St. Lucia. There seem to be significant differences between cultivars/types on the basis of pulp colour and fruit characteristics. The breadfruit tree requires 1800 - 3000mm (75 - 120 inches) of rainfall and full sunlight with temperatures ranging from 70 - 90°F. They prefer sheltered areas and freedom from water logging.

The fruit experiences two main seasons each year, one between April and June and the other between August and October rendering the fruit available over a long period during the year. The plant may be found island-wide provided that conditions are suitable. It is estimated that there is an equivalent of 758 acres of the crop

in St. Lucia though no organised planting exists. Production is estimated to be over 1500 tons per year.

3. PESTS AND DISEASES

These invariably cause losses in fruit crop yields in St. Lucia. The lack of extensive research into this area leaves much still to be discovered in terms of the range of insects and pathogens that limit the performance of these crops. The following is a description of the better known pests and diseases that affect the crops concerned.

3.1 MANGO

The most important pest is the Mango Seed/Stone Weevil, (*Sternochetus mangiferae*). The adult lays its eggs singly on the young fruit, also on mature green to ripe ones. The eggs are laid near the posterior end of the fruits, in a crescent-shaped area. The egg is covered by sap from the wound which solidifies and so protects the egg. The larva burrows through the pulp and into the seed where it completes its life cycle.

The damage done to the fruit by the larva and adult has no effect on the eating quality of the fruit. However its importance lies in the reduction in germination, and the embargo which ensues from the discovery of the pest, in terms of the export trade.
Other pests include Cocoa thrips, (*Selenothrips rubrocinctus*) which can attack the foliage of the plant.

Scale insects, slugs, birds, ants and epiphytes are also known to occur and do varying degrees of damage.

The most important disease of mango is anthracnose (*Colletotrichum gleosporoides*). This disease is particularly virulent where humid conditions prevail. Anthracnose causes destruction of flowers and reduction in fruit set and poor fruit appearance hence reducing the marketability of the fruit.

3.2 CITRUS

Injury to citrus is caused by the citrus weevils (*Diaprepes* spp) and its larva in the soil. The adult damages the bark and roots often killing the whole tree. The fruit-piercing moth (*Gonodanta* sp) also does damage to citrus. Scale insects are also important in this crop. They suck plant sap and encourage the development of sooty mould. Scale insects may be found in association with ants and aphids. Termites have been found to cause dieback of branches and subsequently trees. Slugs have been found to do damage to the foliage of young plants while birds cause damage to ripe fruits rendering them useless. In some cases epiphytes damage the plant by smothering the younger ones or causing dieback of branches.

The citrus rust mite (*Eriophyes oleivora*) is also of some significance in altering the appearance of the fruit.

A major disease is Greasy Spot (*Mycosphaerella citri*). Also the occurrence of Melanose (*Erisiphe* sp) and Sooty mould (*Capnodium* sp) can be seen to be prevalent in most citrus-growing areas.

Wither tip of limes causes death of young green shoots. Fruit may bear large corky cankerous areas and the foliage may be spotted or distorted.

Citrus scab (*Elsinoe fawcetti*) can be seen in many areas in St. Lucia causing a wart-like growth on the surface of fruit and leaves and so rendering the fruit deformed and unmarketable.

3.3 AVOCADO

The only major disorder is root rot (*Phytophthora cinnamoni*) which causes death of both young and mature trees. However the disease is prevalent in poorly drained areas.

No major pests occur in this crop though weevils and scale insects do some damage.

No well-defined integrated pest or disease control strategy exists in fruit crop production in St. Lucia though inputs, in terms of chemical pesticides, are made available to farmers. Treatment of disorders are advised by the extension service and may be either on the basis of sanitation and husbandry practices and/or chemical treatments.

4. PLANT QUARANTINE ASPECTS

One major setback in the export of fruit from St. Lucia is the discovery of the Mango Seed/Stone Weevil (*Sternochetus mangiferae*). The pest was confirmed to be in St. Lucia in 1984 and resulted in an embargo prohibiting the export of mangoes to the major regional market, Barbados. The pest is of quarantine significance in the Americas and the Caribbean. The report of the pest was the first in this part of the world. The discovery of this pest has stimulated much consideration in the islands and a regional survey has been prescribed to ascertain its distribution.

Export of fruits to the USA from St. Lucia, as is the case with many other territories, is seriously hampered by the presence in those territories of one or more of the fruit flies. In St. Lucia one fruit fly is known and was isolated from the Hog Plum (*Spondias mombin*). The presence of this fly (*Anestrepha obliqua*) makes it necessary that treatment of fruits be carried out in order to qualify for entry into the USA. The lack of such treatment in St. Lucia has prevented the further exploration of export of fruits to this market.

5. MARKETING

The marketing organisations and channels can be summarised as appears in Figure I. The importance of the channels by virtue of the percentage of the total output which they handle is shown.

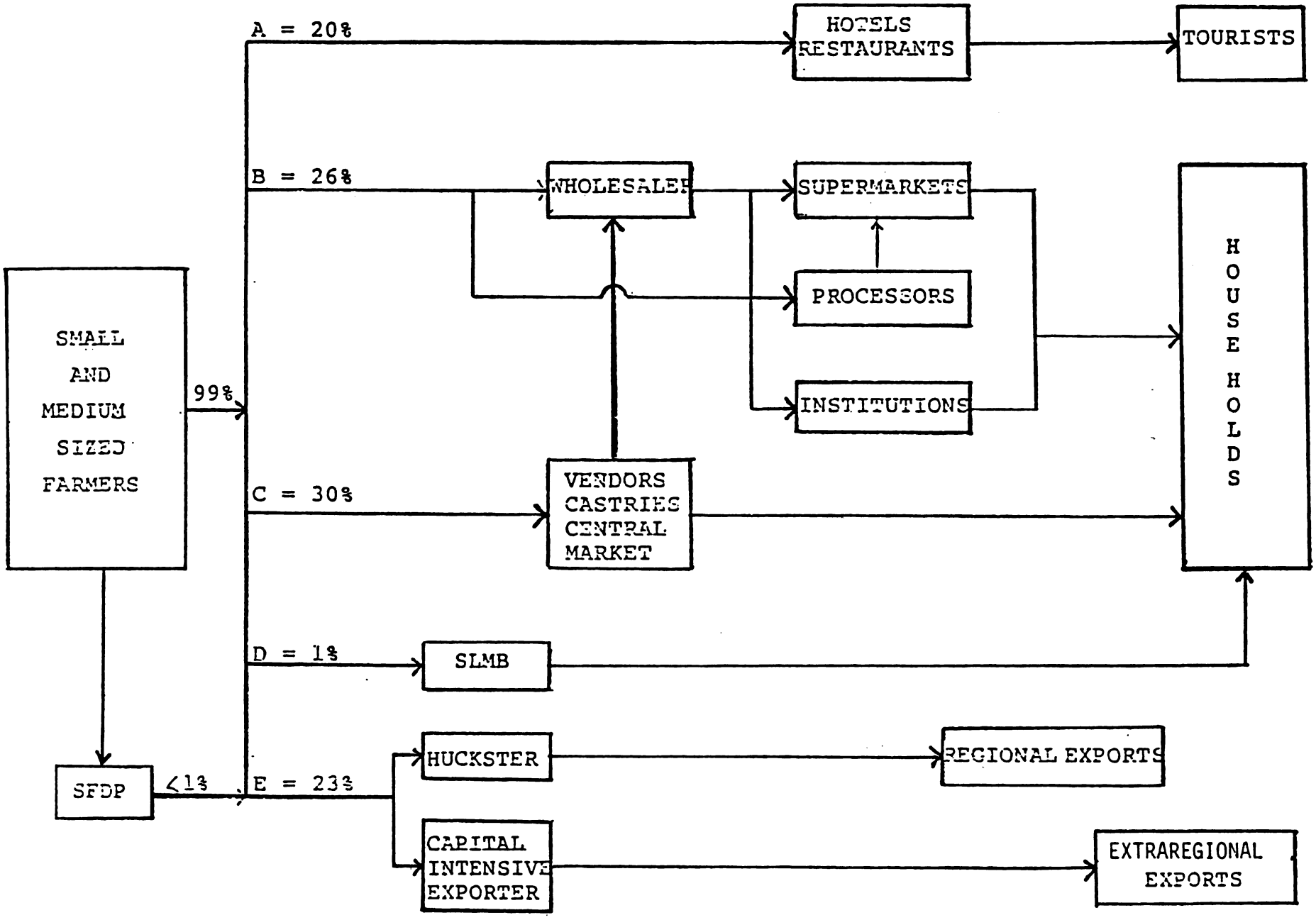


Figure 1: Marketing channels for fresh fruit in St. Lucia

IICA September 1985

5.1 THE CHANNELS:

There are five principal marketing channels for fresh fruit (other than banana) between farmer and consumer as shown below. The first three represent produce flows through the free market and are used for domestic consumption and account for 76% of the total output. The fourth channel, the St. Lucia Marketing Board accounts for a meagre 1% of the output and the fifth, the Huckster and Capital intensive exporter account for 23%.

The role of the participants is described in brief as follows:

5.1.1 Farmers

The farmers who grow fruit other than bananas are small scale growers who operate on plots of 0.5 acres to 5 acres. From the harvest, items are selected for the market while the rejects or culls are consumed at home. The marketable portion of the harvest is packaged in boxes or bags and transported to the central market, hotels, supermarkets, restaurants, processors or institutions (hospitals etc.)

5.1.2 Wholesalers

These represent the intermediaries between farmers and retailers such as hotel, restaurants, processors, etc. His basic service is as a collector of produce from many small farmers, thus being able to meet the demand of his customers. This participant has access to transport and thus buys at farm gate prices and transports directly to his buyer/customer or takes the produce to be further prepared for delivery. In some cases the wholesaler may purchase produce from the farmer or his wife at the Castries market.

5.1.3 Vendors

These operate out of the Castries market and are relatively small retailers. They may have fixed stalls within the market place where they also sell dry goods and arts and crafts. Alternatively, they may operate along the sidewalks bordering the public market where they sell strictly produce and can compete more favourably. These may also be mobile retail vendors who operate on street corners and points where there is heavy pedestrian traffic. These vendors are particularly numerous on Fridays and Saturdays which are the the main market days.

5.1.4 S.L.M.P.

St. Lucia Marketing Board was established since the early nineteen seventies to serve as the main channel for import and export of agricultural produce (except bananas and coconuts) and also to serve as a local market. However presently the Board is the sole exporter of ginger and handles small amounts of horticultural crops which are brought in by farmers only when better cannot be done. Its facilities include one small retail outlet near the Castries market.

5.1.5 Retailers and processors

These constitute essentially supermarkets, restaurants, hotels, institutions and food processors. These usually order directly from the farmers at pre-established prices and do grading and further preparation at their premises.

5.1.6 Hucksters

These are prevalent throughout the Eastern Caribbean and in St. Lucia, are responsible for about 70% of the total crop exports. They buy from the farmer at negotiated prices

and prepare the product for export mainly by inter-island schooners.

5.1.7 Capital intensive exporters

These are characterised by having access to larger amounts of capital than the hucksters, better market information, and access and experience with extra-regional markets. Like the hucksters they buy high quality produce from the farmer and do carry out the necessary preparation for transport by air to their destinations.

5.1.8 S F D P

The Small Farmer Development Project is a pilot project aimed at improving the production and marketing of food crops particularly those with export potential. Trial shipments have been made to the extra-regional markets. The objective of the project is to establish centres for distribution of inputs to, and collection of produce from farmers.

For most of the commodities dealt with in this presentation, the local market represents the major outlet followed by the regional market, in all cases except mangoes where the extra-regional market is the next most important outlet. A relatively small but significant proportion of the production goes to the extra-regional market.

6. HUMAN RESOURCES

Specialists involved with fruit crop Development in St. Lucia came essentially from:

- WINBAN Research

- CARDI

- IICA

- Ministry of Agriculture

Of these, WINBAN Research involves developmental work aimed at bananas. At this station there are two plant pathologists, an agronomist, soil scientist and a post-harvest physiologist. IICA employs a crop protection specialist and a marketing specialist while CARDI employs four agronomists and one weed specialist. These specialists offer assistance when necessary, in areas of concern, to the Government of St. Lucia.

On the other hand, the Ministry of Agriculture employs six agronomists, two crop protection cfficers and a marketing specialist. The services of these specialists are spread over the agriculture field and are not specifically involved in fruit crop development. The other Institutions lend support to the Ministry's programmes alongside the routine execution of their own institutions' efforts which may be of a regional or sub-regional nature.

7. DEVELOPMENTAL PLANS

Essentially plans concerning fruit crop production are geared towards rehabilitation rather than further expansion. The existing acreage of fruit crops particularly citrus, mangoes and avocados have been a result of recent expansion programmes and therefore have not yet achieved their potential productivity. However, the aftercare of those crops leaves room for improvement. This aspect of production is to be encouraged in other phases of the Orchard Crop Diversification Project with a view to exploiting the potential productivity as well as reducing field losses. Alongside this development will be a stronger effort in the area of marketing, since this has been found to be a major limiting factor in agricultural development in St. Lucia.

Contributions from:

Mr. Everton Ambrose
Crop Protection Specialist - IICA

Mr. Jerry LaGra
Marketing Specialist - IICA

Mr. Andrew Satney
Marketing Specialist - Ministry of Agriculture

Mr. David Jackson, - BDD
Manager of Orchard Crop Diversification Project

COUNTRY PAPER - SURINAME

by

F.W. Soerodimedjo

Agronomist

Agricultural Experiment Station - Paramaribo

1. INTRODUCTION

The climate conditions existing in Suriname are ideal for growing some tropical fruit tree crops. Agricultural activities, however, are mainly restricted to parts of the young coastal plain and to an area of the old coastal plain south of Paramaribo, the capital of Suriname.

The interior of the country is relatively uninhabited, except for the settlements of Bushnegroes and Amerindians along the rivers. These people practice systems of shifting cultivation for their subsistence farming. Moreover, large parts of the rest of the country are very sparsely inhabited.

The research programme on fruit tree crops at the Agricultural Experiment Station in Paramaribo is restricted only to those fruits, such as passion fruit (*Passiflora edulis f. flavicarpa*), papaya (*Carica papaya*), W.I. cherry (*Malpighia punicifolia*), soursop (*Annona muricata*), avocado (*Persea americana*), citrus spp. and pineapple (*Ananas comosus*) that are more important to commerce.

2. SITUATION AND CLIMATE

The country is situated on the northeastern coast of South American between 2^{o} and 6^{o} North latitude and between 54^{o} and 58^{o} West longitude. It covers an are of about 164,000 square kilometers. The country can be divided from north to south into four zones:

- The young coastal plain: an area of approximately 10,000 km^2. The soil consists predominately of marine clay, the surface of which lies below high tide level.

- The old coastal plain: proceeding to the south. It consists mainly of silty clay areas, parts of which are swampy.

- The Zandery formation or Savannah belt: a rather narrow strip of about 5,000 km^2 in area. This is comprised largely of quartz sand, which has been deposited by rivers.

- The interior uplands: the southernmost zone of Suriname comprising about four fifths of the whole country. This is mostly hilly and there are some mountain chains which reach heights up to 1,300 meters. The soils overlie very rocky formations and bear mostly tropical rainforest.

As can be expected from its location Suriname has a typically equatorial climate. Four seasons can be distinguished:

- a long rainy season (April-July),
- a long dry season (August-November),
- a short rainy period (December-January) and
- a short dry period (February-March).

The temperature is high throughout the year with an annual mean ranging from 26.6 to 27.1 ^{o}C. The relative humidity of the air is generally high with an annual mean of about 80%. The winds are usually weak, hurricanes are unknown. The wettest months are May and June and the driest months are September and October.

3. FRUIT CROP PRODUCTION

Observation and research on fruit trees have already proved that some of the finest cultivars of fruit crops are in existence and they can also be kept successfully in cold storage for two to three weeks,

indicating therein that these fruits can be exported to foreign countries in good condition.

As marketing prospects seemed to be good, intensive research especially on papaya, passion fruit, soursop, W.I. cherry, orange and pineapple has started and has been carried out in Suriname by the Division of Pomology at the Agriculture Experiment Station in Paramarbio with relation to cultivation methods, production, pests and diseases.

Regarding papaya (*Carica papaya*) there are over nine local and two foreign strains with both yellow and red flesh colour already growing in different districts without any serious problems, from a cultivation technique point of view. The area and production of papaya at present is just sufficient for the local consumption. At the plantation in the experimental gardens with roughly 1600 plants per hectare the actual yield amounts to 30-45 tons/ha/year for the different strains.

Passion fruit (*Passiflora edulis V. flavicarpa*) is until now cultivated on an experimental scale and also by some farmers on a small scale with a total area of about 10 hectares just for local consumption. The plant is a vigorously growing vine climbing by tendrils. It produces edible fruits with a yellowish aromatic pulp containing many seeds, each individually enveloped by a juicy aril. Because of the exquisite flavour and good potentials for processing of nectars, beverages and jams, there is a worldwide demand for the sourish juice and its derivative.

From the tested soils, the sandy loam and the fertile and well-drained clay soil with bagasse topsoil seemed to be the most suitable. On a lateritic and poor sandy soil, low yields were obtained. On sandy loam soils the yields in the first production year were 5.5 tons/ha and in the second year 12.5 tons/ha. After intensive selection and improved cultivation methods on fertile clay soils, yields were obtained from 10,5 tons/ha to 15 tons/ha in the second production year. Harvesting takes place the year-round, with June-August and January-March as peak periods. In Suriname yellow passion fruits are propagated from both

seeds and cuttings of good planting material.

Soursop (*Annona muricata*) has been of little importance in Suriname till now, mainly because of severe infestation of the fruits by the soursop moth (*Cerconota anonella*) and the soursop wasp (*Bephrate maculicollis*). As marketing prospects seemed to be good, research was started to control these pests. Investigation was performed on 1.5 hectares in a experimental garden of the Agricultural Experiment Station at Jarikaba. With a plant density of 278 trees per hectare a productive capacity of 15 tonnes of fresh fruit per hectare was registered, most of the fruits being covered with nylon netting or plastic bags to prevent infestation by these insects.

Regarding the cultivation of the W.I. cherry (*Malpighia punicifolia*) no serious problems have arisen, except the method of manual harvesting, which is very labour consuming. Growing on a fertile clay soil in the experimental garden at Jarikaba with a plant density of 278 trees per hectare a yield amounting to 15-20 tons was registered.

Speaking about orange (*Citrus sinensis*) it is already known that the international market offers very good prospects for the sale of orange as both fresh fruit and orange juice. Transporting this fruit in both fresh and pulp form by ship under refrigerated conditions from Paramaribo to other countries has met with some problems nowadays because of the currently unfavourable situation of Suriname with regard to shipping. The total areas growing oranges amount to more than 2000 hectares of which about half is in production.

Pineapple (*Ananas comosus*) cultivation takes place especially in both the interior on sandy soils of the Zandery formation (Coebiti) and the young coastal plain (Saramacca and Marowjne district). Research on this crop regarding cultivation method, selection, plant density, fertilization methods, weed control, pests and diseases in relation to different soil types was carried out in both the interior (Coebiti) and in the young coastal plains (Saramacca district).

4. PEST AND DISEASES

4.1 PAPAYA

Pests on papaya hardly form a serious problem in Suriname. Once in a while damage from the white flies (*Aleurocanthus woghuni*), which has been active on several plantations, occured. However, the damage was limited and intensive control did not seem necessary. Scale insects and mealy bugs were repeatedly found on the stem and fruits. Treatments with Gusathion (1,5 l/ha) resulted in good control.

On the other hand diseases in Suriname present a serious threat to the majority of fruit crops. Papaya plantings also suffer from several diseases. In poorly drained areas the Phytophthora species (footrot) causes many failures particularly with papaya seedlings.

Also a serious treat for papaya orchards in Suriname is the so-called dieback disease which was observed first in December 1976. The first symptoms are a bended growing point and light green younger full grown leaves. At a later stage rotting at the flower stalk and leaf basis makes its appearance. Finally a bare stem remains which is rotted from top to bottom. Up till now the cause of these diseases is not know. Physical and chemical analysis of soil samples, taken at diseased and healthy plants did not show any difference in chemical fertility. Neither did the soil differ in physical proporties around diseased and healthy plants. Infested plants appeared indiscriminately over the entire experimental area. It seemed, that the disease did not spread from plant to plant and is consequently not caused by a pathogen, but probably has a pedological cause. Topping off the infected plants to about 50cm above the ground level prevents further rotting. Most of the topped plants again sprouted without dieback symptoms. Half a year after outbreak of the disease no new infected plants were seen.

4.2 PASSION FRUITS

Over the past fifteen years of passion fruit research in Suriname, many field experiments have been conducted by research workers from a great variety of disciplines.

Pests and diseases appeared to be the most important limiting factors in the experimental passion fruit fields.

An unidentified insect larva appeared incidentally as severe stemborer causing the death of the entire plant. Probably several, but at least two Lepidoptera species occur. Intensive entomological research has not been carried out in the experimental garden. Mites (*Tetranynchus* sp. and *Polyphagotarsonemus latus*) and bugs (*Anisocelis foliacea*) were found frequently throughout the growing season, especially in the dry season. The bugs suck the young fruits, which can cause malformation and secondary infection by fungi. Effective chemical control is not yet known. Besides, the use of insecticides can also be dangerous for the timber-bee (*Xylocopa* spp.) and the honey-bee (*Apis mellifera*), which are responsible for the pollination of the flowers.

In the experimental garden with passion fruit, nematodes such as *Rothlenchus reinformis, Helicotylenchus* sp., *Trichodorus* sp., *Cricenemoides* sp. and *Rotylenchulus* sp. have also been found in such densitities, that these root parasites may cause, according to the Division of Nematology, a problem in the future.

The widely occurring passion fruit fungus *Alternaria passiflorae* has never been found in the plantation. This fungus has been reported from many other passion fruit producing countries. However, the main problem associated with the production of the passion fruit crop in Suriname seems to be the fungus *Colletotrichum gloeosporioides*, causing severe dieback of shoots and fruitrot. Because passion fruit plants produce their flowers at consecutive nodes along the last seasons' growth,

inhibition or loss of growing points renders the plant worthless for production. The disease has become increasingly prevalent during the last ten years and the destructive effects of repeated heavy infestations are very apparent in the experimental areas.

In the past, several research workers studied the disease but more attention has been given to horticultural aspects of passion fruit growing rather than detailed work on this disease. Due to continuously discouraging results from the relatively high capital investment on trellises in the crop, passion fruit culture in Suriname is still limited to experimental gardens and some small home gardens. This is in spite of interest shown by farmers to grow this crop. There is still a great demand and there are possibilities to expand passion fruit production in Suriname.

4.3 SOURSOP

Marketing prospects of both the fresh soursop fruit and juice are nationally and internationally very good. However, because of the serve infestation of the fruit by the soursop moth (*Cerconota ananella*) and the soursop wasp (*Bephrata maculicolis*), the agricultural importance of the crop has stayed in the background.

Caterpillars of *Cerconota anonella* (Sepp.), a greyish-white moth with a wing span of 19-27 mm and delicate brownish markings on the fore wing, can be considered the most important pests of the fruit of soursop (*Annona muricata*) in Suriname. Infested fruits undergo local retardations in their growth and, as a result, fail to attain the normal size and shape. Moreover, the tissues around the exit openings at the surface of the fruits turn dark brown and harden or decay, which renders the fruits worthless. Because the egg-laying of *C. anonella* on the developing Annona fruits probably extends over a long period, control of the eggs or of the newly hatched larvae by means of insecticides is not likely to succeed.

For this reason, bagging of the young fruits in nylon bags should be recommended as a preventive control method.

A simultaneous attack by the soursop wasp (*Bephrata maculicollis*) aggravates the poor development of the fruits and hastens their decay. Young fruits of soursop regularly become infested by this insect. The damage, cause by this insect manifests itself in:

- remaining small fruits and disturbed development,
- little extradition of juice
- bad taste of juice or nectar.

Because of the severe infestation of the fruit by both the soursop moth and soursop wasp this crop has been of little importance in Suriname for commercial purposes.

4.4 ORANGE

In Suriname, citrus ranks third among the economically important crops. The citrus rust mite, *Phyllocoptruta olevora*, forms the most important pest. Trees infested with rust mite are often simultaneously infested with the greasy spot fungus, *Stenella* sp., a disease mainly of the leaves. Citrus rust mite plays a role in infestion of leaves with greasy spot fungus and rust mite infestations are associated with subsequent defoliation of the trees. Citrus rust mite on fruits discolours the skin (Fruitrissetting). Because of blemishes resulting from rust mite injury, the fruits of both grapefruit and orange are unattractive for export purposes.

The occurrence of virus diseases Tristeza and Exocortis may form also another problem and threat for the existing orange plantation.

5. UTILIZATION OF FRUIT PRODUCTS

At present there are local fruit industries converting the fruits to jams, juice and other fruit drinks. One of these industries is under the aegis of the government, in this case the Ministry of Agriculture, Animal Husbandry and Fisheries. All fruits obtained from the experimental gardens are regularly sent to the fruit industries and the Agro-technology Division of the Agricultural Experiment Station for analysis and other purposes.

6. CONCLUSION

In the past, fruit producers failed to recognize natural pests and diseases as serious constraints to production since losses from such sources were often not noticed, for example, retarded growth of trees, and attacks were not easily identified. There is reason to assume that fruit production can be greatly increased if backyard farmers pay more attention to pest and disease control.

COUNTRY PAPER - TRINIDAD AND TOBAGO

by

Lennox Andrews, Agronomist

Ministry of Agriculture, Lands and Food Production

Crop Research Division

Central Experiment Division Station

Trinidad and Tobago

1. INTRODUCTION

Trinidad and Tobago, the southermost of the Caribbean island chain, have surface areas of 4,828 sq. km and 300 sq.km respectively. Tobago is 32 km northeast of Trinidad.

Forest and tree crops occupy most of the eastern two-thirds of Trinidad whereas field crops, mainly sugar and rice, occupy the remaining western part. Some fifteen percent of the total land area is planted in tree crops mainly cocoa, coffee, coconuts, citrus and other fruit trees (2). The easter area has a mean annual rainfall of approximately 2250mm.

Agriculture in Tobago (1) is characterized by small farms (2.5ha and under) operated on a part-time basis. The major tree crops consist of cocoa, citrus and coconuts, generally on large (over 20ha) estates. Other fruit crops are normally grown for home use only. Mean annual rainfall is about 1500mm in the southwest and over 2250mm in the northwest of the island. Mean minimum and maximum temperatures for both islands are $22^{o}C$ and $31^{o}C$ respectively.

The agricultural sector of the two island economy has been depressed for more than a decade. This is somewhat reflected in a food import bill that has risen from $103.4m in 1970 to $900m within the last two years. Fruit crop farming has low priority in domestic agriculture with the exception of citrus. This is in contradiction with an increasing popularity of local fruit and increasing expenditure on imported fresh and processed fruit (Table 1).

TABLE 1. Import[1] values ($TT) for fruit and fruit products.

Commodity	1979	1980	1981	1982	1983
Citrus juices	17,476,362	17,110,378	11,402,754	18,897,194	17,666,415
Other juices	1,011,835	2,861,702	4,183,670	1,018,534	2,883,493
Preserved/process fruits	3,967,256	5,447,538	4,6300,595	5,473,403	6,678,267
Fresh fruits Apple/pears/ Quinces	5,369,663	6,850,270	7,091,160	9,525,079	9,154,764
Grapes	1,254,499	2,119,554	2,902,703	4,173,043	4,108,251
Other	74,481	30,586	168,194	306,291	890,935
	29,154,096	34,420,028	30,379,076	39,393,544	41,382,125

[1]Data from the Central Statistical Office, Trinidad and Tobago

2. FRUIT CROP PRODUCTION

The major cultivars, seasonality, hectarage and recommended spacing is supplied in Table 2. A country survey of major commercial fruit farmers (excluding citrus and bananas) was conducted. This data is supplied in Table 3 and indicates the relative importance of the fruit crops.

3. PESTS AND DISEASES

Major and minor pests (3, 4, 5, 9) and diseases (C. Persad, pers. comm) together with methods of control are supplied in Tables 4 and 5 respectively. Some very minor pests nor included here are recorded elsewhere (3,9) as being found on the respective crops.

4. PLANT QUARANTINE ASPECTS

Plant quarantine procedures are governed by fairly old legislations (8) dating pack to 1940. In essence all fruits from the British West Indies may be imported once accompanied by a certificate of inspection from the country of origin. However, this is currently under review especially in light of the serious risk of introducting the Caribbean Fruitfly (*Anastrepha suspensa*) from Jamaica. Planting material of citrus and a few other crops requires a special permit from the ministry of Agriculture, Lands and Food Production (MALFP). The 'British West Indies' refers to all English speaking islands in the Greater and Lesser Antilles and excludes Bermuda, Bahamas, Guyana, the Virgin islands and Belize.

5. POST HARVEST PROBLEMS

The major postharvest problems fall in five categories:

- The high incidence of disease such as anthracnose in mango, granadilla and papaya.
- The absence of maturity indices crucial in the management of orchard production systems. Notable for which this type of information is lacking are sapodilla, mamey apple and granadilla.
- The lack of application of adequate handling techniques especially in the case of soft fruit. The result is early deterioration and other associated problems.
- Insufficient information on appropriate storage conditions for local cultivars.
- Inadequate transportation units for export marketing.

The Research Division of the MALFP is addressing some of the above problems through its Post Harvest Unit.

TABLE 2. Major fruit cultivars, season, size, and spacing in Trinidad and Tobago

CROPS	CULTIVARS	SEASON	SIZE (ha)	RECOMMENDED SPACING m
Citrus			2430	
Orange *Citrus sinensis*	Early:eg. Parson Brown, Hamlin.	Nov-Dec		6 x 8
	Late:eg. Valencia	Mar-April		
	Mid-seasonal:eg. Navel, Pineapple	Jan-Feb		
Grapefruit *C. paradisi*	White marsh	Nov-Feb		7 x 9
Lime *C. aurantiifolia*	W.I. Lime	Jun-Oct		5 x 8
Mandarin *C. reticulata*	Portugal	Nov-Dec		5 x 8
	Dancy	Dec-Jan		
Mango *Mangifera indica*	Julie	Jun-Sept	N.A	6 x 8
	Long, stratch, Doux douce, rose.	Jun-Aug		8 x 10
Avocado *Persea americana*	Pollock	Jun-Sept	N.A.	7 x 9
	Lula	Oct-Jan		8 x 10
	seedling	Jun-Jan		
Papaya *Caruca papaya*	Solo sunrise	All year	N.A.	2 x 3
	Scott			
W.I. Cherry *Malphighia glabra*	Seedling	about 3 crops/year	N.A.	3 x 5
		Jan-Feb		
		May-Jun		
		Sep-Oct		

TABLE 2 (continued)

CROPS	CULTIVARS	SEASON	SIZE (ha)	RECOMMENDED SPACING m
Golden apple *Spondias cytherea*	Seedling	July-Oct	N.A.	8 x 10
Soursop *Annona maricata*	Seedling	Jan-Mar	N.A.	4 x 6
Custard apple *Annona reticulata*	Seedling	Jan-Mar	N.A.	7 x 9
Sugar apple *Annona squamosa*	seedling		N.A.	4 x 6
Guava *Psidium guajava*	Centeno Prolific (Processing type)	Feb-Mar Aug-Sept	N.A.	5 x 8
Pineapple *Ananas comosus*	Cedros or Deltado (Red Spanish type)	All year	N.A.	0.45 x 0.60
Sapodilla *Manilkara zapota*	Demeillac	April-Jun	N.A.	4 x 6

TABLE 3. Production of major fruit crops by country in Trinidad

Country	Crop	Size in ha	No. of farmers	Spacing	Cropping pattern
Victoria	Mango	2.0	3	N.A.	mixed
	Guava	1.6	2	6.1 x 6.1 m	pure
	Pawpaw	1.6	3	2.4 x 1.2 m	pure
	Avocado	1.6	2	6.9 x 6.9 m	mixed
	Pineapple	5.2	3	.35 x .35 m	pure
Narva/ Mayaro	Mango	1.6	1	6.5 x 6.5	mixed
St. Patrick	Pineapple	5.7	2	N.A.	mixed
	Avocado	14.7	4	N.A.	pure
	Mango	7.9	4	N.A.	pure/mixed
St. Georges	Mango	3.6	5	N.A.	mixed
	Avocado	2.4	1	N.A.	pure/mixed
	Pawpaw	2.4	2	2.4 x 2.4 m	pure/mixed
	Guava	2.0	1	6.1 x 3.0	
Caroni	Mango	2.4	4	N.A.	pure/mixed
	Avocado	4.0	5	N.A.	pure/mixed
	Pineapple	2.9	3	N.A.	pure/mixed
	Cashew	12.5	6	N.A.	pure
	Exotic fruit	6.1	1	N.A.	pure
St. Andrew/ St. David	Mango	8.6	5	6.1 x 6.1 m	pure/mixed
	Pineapple	0.2	1	N.A.	mixed
	Avocado	1.6	2	7.6 x 7.6 m	mixed

TABLE 4. Major and minor pests of fruit crops in Trinidad and Tobago

CROP	PEST	ORGANISM	CONTROL	CATEGORY
Citrus	Leaf cutting ant	*Trachymyrmex urichi* *Acromyrmex octospinosus* *Atta cephalotes*	Aldrin Mirex	Major
	Pegong bee	*Trigona* spp.	Destroy nest	Major
	Yellow-tail bird			Major
	Scale insect	*Coccus hesperidium* *Coccus viridis* *Lepidosaphes gloverii* *Sclenapidus articulatus* *Unaspis citri* *Icerya purchasi* *Lepidosaphes beckii* *Saissetia oleae* *Ceroplastes floridensis* *Pulvinaria pyriformis* *Chrysomphalus anonidum*		Minor
	Beetles causing bark damage	*Glyptoscelis antipennis* *Cratosomus punctulatus*	Lannate and Furadan	Minor
	Aphids	*Toxoptera aurantii* *Aphis gossypii*		Minor
	Leaf-eating caterpillar	*Papilo cresphontes*		Minor
	Mites	*Phyllocoptrata oleivora*	Tambo, Kelthane	Minor
	Mealy bugs	*Planococcus citri* *Puto barberi*	Malathion or Rogor	Minor

TABLE 3. Production of major fruit crops by country in Trinidad

Country	Crop	Size in ha	No. of farmers	Spacing	Cropping pattern
Victoria	Mango	2.0	3	N.A.	mixed
	Guava	1.6	2	6.1 x 6.1 m	pure
	Pawpaw	1.6	3	2.4 x 1.2 m	pure
	Avocado	1.6	2	6.9 x 6.9 m	mixed
	Pineapple	5.2	3	.35 x .35 m	pure
Narva/ Mayaro	Mango	1.6	1	6.5 x 6.5	mixed
St. Patrick	Pineapple	5.7	2	N.A.	mixed
	Avocado	14.7	4	N.A.	pure
	Mango	7.9	4	N.A.	pure/mixed
St. Georges	Mango	3.6	5	N.A.	mixed
	Avocado	2.4	1	N.A.	pure/mixed
	Pawpaw	2.4	2	2.4 x 2.4 m	pure/mixed
	Guava	2.0	1	6.1 x 3.0	
Caroni	Mango	2.4	4	N.A.	pure/mixed
	Avocado	4.0	5	N.A.	pure/mixed
	Pineapple	2.9	3	N.A.	pure/mixed
	Cashew	12.5	6	N.A.	pure
	Exotic fruit	6.1	1	N.A.	pure
St. Andrew/ St. David	Mango	8.6	5	6.1 x 6.1 m	pure/mixed
	Pineapple	0.2	1	N.A.	mixed
	Avocado	1.6	2	7.6 x 7.6 m	mixed

TABLE 4. Major and minor pests of fruit crops in Trinidad and Tobago

CROP	PEST	ORGANISM	CONTROL	CATEGORY
Citrus	Leaf cutting ant	*Trachymyrmex urichi* *Acromyrmex octospinosus* *Atta cephalotes*	Aldrin Mirex	Major
	Pegong bee	*Trigona* spp.	Destroy nest	Major
	Yellow-tail bird			Major
	Scale insect	*Coccus hesperidium* *Coccus viridis* *Lepidosaphes gloverii* *Sclenapidus articulatus* *Unaspis citri* *Icerya purchasi* *Lepidosaphes beckii* *Saissetia oleae* *Ceroplastes floridensis* *Pulvinaria pyriformis* *Chrysomphalus anonidum*		Minor
	Beetles causing bark damage	*Glyptoscelis antipennis* *Cratosomus punctulatus*	Lannate and Furadan	Minor
	Aphids	*Toxoptera aurantii* *Aphis gossypii*		Minor
	Leaf-eating caterpillar	*Papilo cresphontes*		Minor
	Mites	*Phyllocoptrata oleivora*	Tambo, Kelthane	Minor
	Mealy bugs	*Planococcus citri* *Puto barberi*	Malathion or Rogor	Minor

TABLE 4 (continued)

CROP	PEST	ORGANISM	CONTROL	CATEGORY
	Stinging ant	*Solenopsis geminata*	Aldrin	Minor
	Balata ant	*Azetca* sp.	Aldrin	Minor
	Fruit piercing moth	*Gonodonta* spp.	Fenthion	Minor
	Fruit boring moth	*Laspeyresia* spp.		
	Grasshopper	*Coscineuta virens*	Aerial sprays	Minor
		Tropidacris dux		
Mango			-	-
Avocado	Termites	*Neotermes holmgreni*	Lead arsenate	Minor
	Weevil	*Diaprepes albrevitus*		Minor
	Coconut scale	*Aspidiotus destructor*		Minor
Papaya	Fruit fly	*Toxotrypana curvicauda*	Fenthion	Major
	Scale insects	*Pseudaulacaspis pentagona*	Dimethoate or Diazinon	Minor
W.I. Cherry	Cherry lace wing bug	*Phymacysta tumida*	Fenthion	Major
	Cherry fruit weevil	*Anthonomus testaceus*	Fenthion	Major
Golden Apple	-	-	-	-
Annonas (soursop)	Moth	*Cerconata annonella*	Bagging	Major
	Wasp	*Bephroides maculicollis*	Lebaycid (Fenthion)	Major

TABLE 4. (continued)

CROP	PEST	ORGANISM	CONTROL	CATEGORY
	Butterfly	*Thecla ortygnus*		Minor
	Mealy bugs	*Planococcus citri*	Malathion	Minor
Guava	Guava fruit fly	*Anastrepha striata* *A. bahiensis* *A. fraterculus* *A. mombinpraeoptans*	Fortnightly sprays of fenthion	Major Minor
Pineapple	Pineapple mealy bug	*Dysmicoccus brevipes*	Malathion; Aldrin for associated ants	Major
	Butterflies	*Thecla* sp.	Sevin	Minor
	Rhinoceros beetle	*Strategus* sp.		Minor
Sapodilla	Sapodilla fruit fly	*A. serpentina*	Fenthion	Major

TABLE 5. Major and minor diseases and their control in Trinidad and Tobago

CROP	DISEASE	ORGANISM	CONTROL	CATEGORY
Citrus	Foot rot	*Pyhtophthora parasitica* *Phytophthora citrophthora*	Resistant rootstock paring followed by fungicide paste	Major
	Greasy spot	*Mycosphaerella citri*	Copper spray when leaves fully expanded	Major
	Areolate leaf spot	*Corticium areolatum*	Cooper spray on young flush	Minor
	Wither tip	*Gloeosporium limetticola*	Copper spray on young flush and two thirds petal fall	Minor
	Melenose	*Diaporthe citri*		Minor
	Anthracnose	*Colletotrichum gloeosporioides*		Minor
	Damping off	*Pellicularia salmonicolor*	Nursery diseases controlled by removing shade and reducing humidity; soil fungicide drenches for damping off.	Minor
	Sour orange scab	*Elsinoe fawcetti*		
	Root rot	*Sclerotium rolfsii*		Minor
	Thread blight	*Corticium koleroga*		Minor
	Brown rot	*Phytophthora palmivora*		Minor

TABLE 5. (Continued)

CROP	DISEASE	ORGANISM	CONTROL	CATEGORY
	Nematodes	*Tylechulus semipenetrans* *Xiphinema insigne* *Macroposthonia onoensis* *Helicotylenchus dihystera*		Major Minor
	Exocortis Others suspected Psorosis Xyloporosis Stubborn	*Viroid*	Virus-free budwood programme	Unknow
Mango	Anthracnose	*Colletotrichum gloeosporioides*	Benlate alternated with Dithane; plant in dry areas	Major
	Soft nose	Physiological		Minor
	Galling	Etiology unknown		Minor
	Sooty mold	*Capnodium mangiferae*		Minor
	Thread blight	*Corticium koleroga*		Minor
	Nematodes	*H. pseudorobustus* *Meloidogyne* sp. *M. onoensis*		Minor
Avocado	Root rot	*Phytophthora cinnamoni* *Rosellinia* sp.	Ridomil	Major Minor
	Fruit rot	*P. cinnamoni*		Minor

TABLE 5. (continued)

CROP	DISEASE	ORGANISM	CONTROL	CATEGORY
	Anthracnose	*Colletotrichum* spp.	Copper spray	Minor
	Cercospora spot blotch	*Cercospora purpurea*		Minor
Papaya	Anthracnose	*Colletotrichum gloeosporioides*	Spray with Dithane or Trimiltox	Major
	Internal blight	*Cladosporium* sp. *Alternaria* sp. *Penicillium* sp. *Fusarium* sp.		Minor
	Stem canker	*Erwinia caricae*		Minor
	Bunchy top	Mycoplasma	Weekly spray with sevin or malathion	Major
	Ringspot virus	Virus		Minor
	Nematodes	*Meloidogyne incognita* *Rotylenchulus reniformis* *H. dihystera* *H. pseudorobustus* *Tylenchorrhynchus annulatus*		Minor
W.I. Cherry	-	-		
Golden apple	Gumming disease	Etiology unknown		Major
Annonas	Fruit rot (Mummified fruit)	*Colletotrichum gloeosporioides*		Major
Guava	Leaf alga (epiphyte)	*Cephaleuros virescens*		Minor

TABLE 5. (Continued)

CROP	DISEASE	ORGANISM	CONTROL	CATEGORY
	Nematodes	*P. branchyurus* *H. dihystera* *Meloidogyne* spp. *Pratylenchus* spp.		Minor
Pineapple	Nematodes	*Meloidogyne* spp. *Pratylenchus* spp. *Helicotylenchus* spp.	Rotation and Fumazone	Major
	Heart and root rot	*Phytophthora parasitica*	Improve draingage/ fungicide dip before planting	Minor
	Butt rot	*Thielaviopis* sp. *Pythium* sp.		

6. MARKETING

The local market for fresh fruit is somewhat under-developed whereas processed fruit is marketed both locally and abroad at a sophisticated level.

6.1 FRESH FRUIT

A great deal of fresh fruit (300-600 tonnes) e.g. soursop, mango, avocado, sapodilla, golden apple is imported from Grenada (7) and lesser amount from St. Vincent. The majority of the fruit produced locally reaches retail vendors via middle men or directly from farmers. Those producers that operate at relatively high levels of technology market directly to the supermarket chains. A small proportion of the fresh fruit is sold to the Central Market Agency. Very minor quantities of fresh fruit are regularly exported by about six individuals to Barbados, Canada and England. These fruits are pineapple, oranges, mangoes and golden apple.

6.2 PROCESSED FRUIT

There are two large processors of fruit: Co-operative Citrus Growers Association (C.C.G.A.) and National Canners. These two along with al least eight small processors use local fruit. The major exporters are two large processors. The C.C.G.A. exports citrus juice to Barbados and Antigua, and National Canners exports pepper sauce and Jams to the United States, Canada and Holland mainly.

The fruits that are processed and derived products are as follows:

- Citrus - juice
- Papaya - pepper sauce, fruit balls
- Tamarind - fruit balls
- Granandilla - pepper sauce

- Mango - anchar, preserves
- Guava - jams, jellies, cheese

Common plums (*spondias purpurea*), Damsel Cherries (*Phyllanthus acidus*) and governor plums (*Flacourtia indica*) are also used for making preserves.

6.3 MARKETING INFORMATION

There are two sources of market intelligence data locally both appearing in the daily newspaper. The Agricultural Development Bank advertises demand and supply information for its clients and publishes wholesale and retail prices as they occur in the central and municipal markets. General market information is also collected by the Planning Division of the MALFP, the Central Marketing Agency, the Central Statistical Office and the Export Development Corporation.

7. HUMAN RESOURCES

At the present time there are several specialists in various disciplines involved in fruit crop research and development in Trinidad. In many cases however this is a partial if not subordinate function. This information is summarised in Table 6. All are part time except the two agronomist with MALFP.

8. DEVELOPMENT PLANS

Policy statements have not been transtated into well-defined strategies or development plans. However major developments are occurring in the citrus industry.

TABLE 6. Number of resource personnel involved in fruit crop development by discipline and organization.

Discipline	Organisation	No. of specialists
Agronomy	A.D.B.	1
	MALFP	2
	Republic Bank	1
	U.W.I.	1
	Caroni	1
(Plant introduction)	Private farmer	1
Pathology	MALFP	1
Nematology	MALFP	1
	CARDI	1
Virology (Citrus)	MALFP	1
Entomology	MALFP	1
	Caroni	1
Entomology	MALFP	1
	CARDI	1
Post Harvest	U.W.I.	1
	MALFP	2
	CARIRI	1
Soils	MALFP	2
Economist	MALFP	1

8.1 POLICY AND STRATEGY

The White Paper on Agriculture (6) contains some broad policy statements that attempt to influence the direction of development in the fruit industry viz. 'the promotion on export trade in non-traditional commodities', the promotion of greater utilization of local foods' and 'intensification of research on a wide range of fruit crops'. The thrust in the area of the development of the fruit industry is reflected in the increase fruit tree production levels of the Division of Horticulture and the credit policies of

the Agricultural Development Bank. However there is no coherent strategy for meeting these broad objectives of the development of the fruit industry cited in the White Paper on Agriculture.

8.2 DEVELOPMENTS

There are two major developments occurring in the fruit industry. The first is the Citrus Rehabilitation programme which aims at a production from 4046.0 ha (10,000 acres), 50% of which will be establishment of new orchards. The second development arised from the diversification programme at Caroni Limited which has recently begun. Citrus (125 ha), pineapple and passion fruit have already been established with the intention of increasing these plantings over the next few years.

9. SUMMARY

All of the many fruit crops grown in Trinidad and Tobago are produced on a small scale except citrus. These crops, including citrus, are subjected to a comparatively wide range of pests and diseased that limits yield. The more pressing problems to be addressed however are of a postharvest and marketing nature. While no distinct strategies are currently employed to develop the fruit industry, citrus rehabilitation has recently been the focus of attention.

Literature Cited

1. ALI, R. et. al. 1973 Agriculture in Tobago. Post of Spain Ministry of Planning and Development. Land Capability Studies Phase II Trinidad and Tobago Report No. 8.

2. HARDY, F. 1974. Land Capability of Trinidad. Port of Spain Government Printery Trinidad and Tobago. Land Capability Survey of Trinidad and Tobago Report No. 6.

3. LAURENCE, G. 1974. A preliminary list of fruit pests in Trinidad Jour. Agr. Soc. Trinidad and Tobago Vol. 74 No. 3.

4. _____ 1977. The fruitfly in Trinidad and Tobago. Jour. Agr. Soc. Trinidad and Tobago Vol. 77 No. 2.

5. POLLARD, G.V. 1982. A review of some major pests of citrus in the Caribbean. St. Augustine, University of the West Indies. Paper presented at the seminar/workshop in Plant Protection in Dominica.

6. Republic of Trinidad and Tobago, Ministry of Agriculture, Lands and Fisheries. 1978. The White Paper on Agriculture. Port of Spain, Government Printery.

7. SIMEON, D.T. 1983. Trade of AGriculture commodities between Trinidad and Grenada. St. Augustine, University of the West Indies.

8. Trinidad and Tobago. Department of Agriculture. 1947. Restrictions on the importation of plants, plant products, soil and dung imposed by regulations under the Plant Protection Ordinance 1940. Port of Spain, Government Printery. Department Leaflet No. 1 of 1947.

9. United Nations. Food and AGriculture Organization. Caribbean Plant Protection Commission, 1972. Plant pests of importance to the Caribbean. Port of Spain, Food and Agriculture Organisation of the United Nations Office for the Caribbean area.

RECOMMENDATIONS OF THE SEMINAR ON PEST AND DISEASES AS CONSTRAINTS IN THE PRODUCTION AND MARKETING OF FRUITS IN THE CARIBBEAN

The participants of the above seminar whose names are listed in the attached annex recommend as follows:

1. PRIORITY RESEARCH AREAS

1.1 That research and information interchange on the control of the following in order of priority, is necessary for the strengthening of the capacity of the Caribbean countries to produce and market fruits in both the regional and extraregional markets.

(1) Fruit flies
(2) Mango seed weevil
(3) Citrus viruses
(4) Mango anthracnose
(5) Avocado Root Rot disease
(6) Papaya Bunchy Top disease
(7) Soursop Wasp
(8) Soursop Moth
(9) Golden Apple gumming disease

1.2 That research on the biology and control of fruit flies of importance in the region, should be carried out at the University of the West Indies and that the results of current efforts on fruit fly control methods being developed in Haiti should be disseminated to other countries of the region.

1.3 Research on the following areas should be given priority in regional and national research programmes.

- Economic evaluation of crop losses resulting from pests and diseases.

- Analysis of pest and disease problems in new cropping systems e.g. high density planting.

- Initiation of studies on major fruit crop (avocado, mango, citrus, breadfruits, etc) using the interdisciplinary approach developed in the seminar from production to the marketing stage.

- Studies on the export potential of breadfruit with special reference to the demand in North America and European markets.

- Studies on packing material boxes, crates and containers for storage and transport of fruits.

- Development of proposals for pulp industry based on the use of local materials for packing and storage of fruits.

- Determination of maturity indices and storage and shelf life and shipping characteristics of non-traditional fruits including annonaceous fruits, breadfruits, and others.

2. MECHANISMS FOR COOPERATION IN FRUIT CROP DEVELOPMENT

It was agreed as follows:

2.1 That there is need for the preparation of a comprehensive project proposal designed to assist the regional governments in the development of the fruit subsector. This project

proposed in addition to facilitate research and information dissemination on the priority problem already listed in 1(a) above should also be designed to achieve the following objectives:

2.1.1 The identification, organization and support of specific research projects.

2.1.2 The identification of support resources of the host country and institutions to carry out the research.

2.1.3 The financing of inservice training to permit an interchange of technical personnel and experiences intraregionally.

2.1.4 Support ongoing research projects and promote the interchange of information.

2.1.5 Create a regional Germplasm Bank for fruit crops.

2.1.6 Identify priority commodities from a marketing point of view.

2.1.7 Create an information bank for fruit pests and disease.

2.2 The execution of the project should be the responsibility of a regional entity.

2.3 Maximum effort should be made to utilize to the fullest the available resources of FAO, IICA, USDA, and others.

2.4 The Regional Plant Protection Specialist in cooperation with other IICA officers particularly the IICA office in

Barbados and representatives of CARDI, U.W.I. and Ministry of Agriculture in Trinidad and Tobago should prepare the projects.

2.5 Such a project should have the approval of all the Ministries of Agriculture.

2.6 An inventory of human and financial resources available in the region to support this project should be undertaken.

2.7 As an initial step, an inventory of pest and ongoing research should be carried out.

3. OTHER DECISIONS AND CONCLUSION

3.1 There is need for the strengthening of plant quarantine systems in the Caribbean with a view to integrating the system more effectively with marketing and crop production programmes.

3.2 There is a need to expose marketing personnel in the Caribbean to the plant quarantine requirements of trade in agricultural produce.

3.3 Research on pest and disease control in fruit should be given priority in national and regional research programmes.

3.4 Countries should be encouraged to prepare emergency action plans for the major pest and disease problems in the region, in order to prepare for the eradication of these of an when they are detected.

3.5 A "who is who" in plant production, plant protection and marketing with special reference to fruit crops should be prepared.

3.6 The participants expressed a high level of satisfaction with the seminar and recommended that there be similar seminars of this integrated type in the future.

3.7 The participants expressed their thanks to IICA and the Ministry of Agriculture in Barbados for the satisfactory arrangements which were made for the seminar.

LIST OF PARTICIPANTS

NAMES	ADDRESS	TELEPHONE NUMBER
BARBADOS		
Michael J, Moran Director	IICA Office P.O.BOX 705 Bridgetown, BARBADOS	425-1432/3/4
Rafael Marte Fruit Specialist	IICA Office P.O.BOX 705 Bridgetown, BARBADOS	425-1432/3/4
Victor Ojeda Agricultural Economist	IICA Office P.O.BOX 705 Bridgetown, BARBADOS	425-1432/3/4
Eslie H. Alleyne Entomologist	Ministry of Agriculture and Natural Resources P.O.BOX 505 Bridgetown, BARBADOS	428-9980
Delaney Barker Snr. Agricultural Assistant	Soil Conservation Unit Haggatts St. Andrew, BARBADOS	422-9192
Barney Callender Agricultural Assistant	MANR, BARBADOS	428-4150
J. Percival Jeffers Deputy Chief Agricul- tural Officer for Research	MANR, BARBADOS	428-4150
Jeffrey E. Jones Entomolgist	MANR, BARBADOS	428-9980/2
Anthony A. Maynard Agronomist	MANR, BARBADOS	428-4150
M.T. Philip	MANR, BARBADOS	428-4150
Stevenson Skeete Senior Agricultural Assistant	MANR, BARBADOS	428-4150
Omer S. Thomas Virologist/Pathologist	MANR, BARBADOS	428-9980/2
Dawn S. Thompson Plant Disease Inspector	MANR, BARBADOS	433-4669

Robert Power Agronomist	Barbados Agricultural Development Corporation Fairy Valley Christ Church, BARBADOS	428-0250
Kay Donawa Librarian/Information Specialist	BADC, BARBADOS	428-0250
Ian D. Chandler Technical Officer	BADC, BARBADOS	428-0250
Muhammad Munir Alam Entomologist-in-Charge	Caribbean Agricultural Research & Development Institute (CARDI) Sugar Technology Research Unit Edghill, St. Thomas, BARBADOS	425-0059
Frances Chandler Agronomist	CARDI UWI, Cave Hill St. Michael Barbados	425-1334
Jeffrey Nurse Extension Officer	BADC, BARBADOS	428-0000/4
Oscar K. Merritt,Jr.	Fitts Village St. James, BARBADOS	424-1994
Peter Chapman	Lot. No. 20 Rowans, St. George BARBADOS	437-9524
Winston Small Executive Secretary	National Council for Science & Technology BNSI Building Flodden, Culloden Road, St. Michael, BARBADOS	426-3870
John Cropper Editor	Caribbean Farm News P.O.BOX 33 Brittons Hill St. Michael, BARBADOS	426-6170
Marvin Hunte Agricultural Representative	DaCosta's Limited Carlisle House Bridgetown, BARBADOS	426-0850
Lemuel Collymore Agricultural Assistant	Soil Conservation Unit Haggatts St. Andrew, BARBADOS	422-9191

Haynesley Benn General Manager	Barbados Agricultural Society The Grotto Beckles Road St. Michael, BARBADOS	436-6680

TRINIDAD

Chelston W.D. Brathwaite Director and Regional Plant Protection Specialist	IICA Office Pannell Kerr Forster Building Tacarigua TRINIDAD	645-1058/9
Lennox Andrews Agronomist	Ministry of Agriculture Lands and Food Production #9 Central Expt. Station Centeno, TRINIDAD	664-5158
Charles Y.L. Schotman Regional Plant Protection Officer	Food and Agriculture 17 Keate Street P.O.BOX 822 Port-of-Spain, TRINIDAD	625-0467
Ralph Phelps Principal Plant Pathologist	CARDI UWI Faculty of Agriculture St. Augustine, TRINIDAD	645-1208
Gene V. Pollard University Lecturer/ Entomologist	UWI St. Augustine TRINIDAD	663-1364
Ena C. Harvey Food Technologist	CARIRI UWI Campus St. Augustine, TRINIDAD	645-1208

DOMINICA

Hannah Clarendon Crop Protection Specialist	Division of Agriculture Ministry of Agriculture Roseau, DOMINICA	2731

GUYANA

Janice Gittens Agricultural Officer	Ministry of Guyana Georgetown, GUYANA	

GRENADA

Paul R. Graham Plant Protection/ Quarantine Officer	Pest Management Unit Ministry of Agriculture Archibald Avenue St. George's GRENADA	

DOMINICAN REPUBLIC

Robert H. Strong Assistant Regional Director Latin America	USDA/APHIS American Embassy, Santo Domingo APO Miami, Florida 34041-0008	(809) 685-9780

VIRGIN ISLANDS

Walter Knausenberger	Virgin Islands Cooperative Extension Service Virgin ISlands Agricultural Experiment Station College of the Virgin Islands P.O.BOX "L", Kingshill St. Croix, U.S VIRGIN ISLANDS 00850	(809) 778-0246

ST. LUCIA

Jerry LaGra Marketing Specialist	IICA Office Choc Bay ST. LUCIA	25482/21688
David Jackson Tree Crops Projects	British Development Division P.O.BOX 1030 Castries, ST. LUCIA	23975
Dunley Auguste Crop Protection Officer	Ministry of Agriculture Research Division Castries, ST. LUCIA	25375

HAITI

Sainphor Balthazar

Plant Protection Service Dept,
of Agriculture of Haiti
Service Protection des Vegetaux
Department de l'Agriculture
Damien, Port-au-Prince
HAITI

SURINAME

Frederik Soerodimedjo
Agronomist

Agricultural Experimental Station
Paramaribo, SURINAME

ABBREVIATIONS

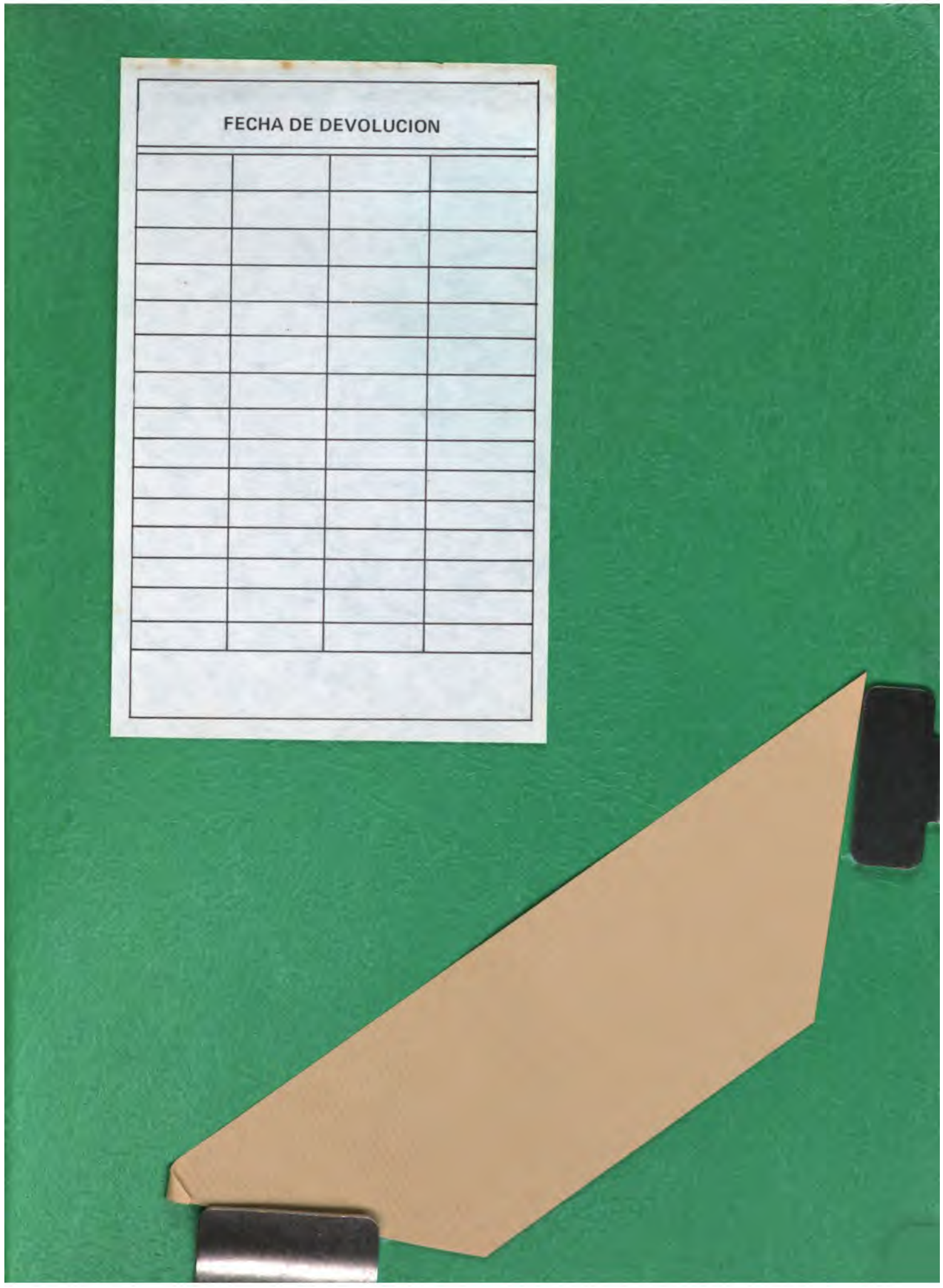
AID (USAID)	Agency for International Development
APHIS	Animal & Plant Health Inspection Service
ACTCO (ATCO)	Agricultural Commodity Trading Co.
BADC	Barbados Agricultural Development Corp.
BDD	British Development Division
BMC	Barbados Marketing Corporation
BNB	Barbados National Bank
CARDI	Caribbean Research & Development Institute
CARIRI	Caribbean Industrial Research Institute
CARICOM	Caribbean Community Market
CBI	Caribbean Basin Initiative
CCGA	Cooperative Citrus Growers Association
CPPC	Caribbean Plant Protection Commission
DBMC	Dominica Banana Marketing Corp.
EC	Eastern Caribbean (Currency)
EDB	Ethylene Dibromide
EDF	European Development Fund
EEC	European Economic Community
EPA	Environmental Protection Agency (U.S.)
FAO	Food & Agriculture Organization
FOB	Freight On Board
IDB	Inter-American Development Bank
IICA	Inter-American Institute for Cooperation on Agriculture
IPM	Integrated Pest Management
LV	Low Volume
MAFCA	Ministry of Agriculture, Food & Consumer Affairs
MALFP	Ministry of Agriculture, Land & Food Products
MANR	Ministry of Agriculture & Natural Resources
MANIB	Marketing and National Importing Board
OECD	Organization for Economic Cooperation and Development

PPQ	Pests & Plant Quarantine
SFDP	Small Farmer Development Project
SLMB	St. Lucia Marketing Board
TCDP	Tree Crop Diversification Programme
TDRI	Tropical Development Research Institute
UCUFFVA	Unitization Committee of the United Fresh Fruit and Vegetable Association
UK	United Kingdom
ULV	Ultra Low Volume
USA	United States of America
USDA	United States Department of Agriculture
UWI	University of the West Indies
WINBAN	Windward Islands Banana Growers Association

VERNACULAR AND LATIN NAMES OF SOME TROPICAL FRUITS

VERNACULAR NAMES	LATIN NAMES
Annato Bixa	*Bixa orellana*
Akee, Spanish lime, Genip	*Melicocca bijuga*
Akee, Jamaican Akee	*Blighia sapida*
Avocado, Pear	*Persea americana*
Bananas	*Musa sapientum*
Barbados Cherry, Acerola W.I. Cherry	*Malphigia glabra*
Bilimbi	*Averrhoa bilimbi*
Breadfruit	*Artocarpus communis*
Breadnut	*Artocarpus communis*
Carambola, Star fruit	*Averrhoa carambola*
Cashew	*Anacardium occidentale*
Cinnamon	*Cinnamomum zeylanicum*
Coconut	*Cocos nucifera*
Custard Apple	*Annona reticulata*
Dunks	*Zizpyhus mauritiana*
Fig (Mediterranean Fig)	*Ficus carica*
Golden Apple, Ambarella	*Spondia cytherea*
Gooseberry, Groselle	*Phyllantus acidus*
Granadilla	*Passiflora quadrangularis*
Grapes	*Vitis* spp.
Grapefruit	*Citrus paradisi*
Guava, guajava	*Psidium guajava*
Hicaco, Fat Pork	*Chrysobalanus icaco*
Jackfruit, Jaca	*Arthocarpus heterophylla*
Jamoon, Jambolan	*Sizygium cumini*
Lemon	*Citrus limon*
Lime	*Citrus aurantifolia*
Mabolo, peach, velvet apple	*Diospyros discolor*
Mamey Apple, Mammee Apple	*Mammea americanum*
Mamey Sapote, mammey	*Calocarpum sapota*
Mandarin	*Citrus reticulata*

VERNACULAR NAMES	LATIN NAMES
Mango	*Mangifera indica*
Nutmeg	*Myristica fragrans*
Orange (sweet)	*Citrus sinensis*
Orange (sour)	*Citrus aurantium*
Passion Fruit	*Passiflora edulis*
Paw Paw, Papaya	*Carica papaya*
Pineapple	*Ananas comosus*
Plantain	*Musa paradisiaca*
Plum (Hog)	*Spondia lutea*
Plum (Jamaican)	*Spondia purpurea*
Pomegranate	*Punica granatum*
Pomerac, Malay Apple, Malacca Apple	*Syzygium malaccensis*
Plumrose	*Eugenia jambos*
Pummelo, pomelo, shaddock	*Citrus grandis*
Rough Lemon	*Citrus limon*
Sapodilla	*Manilkara zapota*
Semitoo	*Passiflora laurifolia*
Sour sop	*Annona muricata*
Star apple, caimito	*Chrysophyllum cainito*
Sugar Apple	*Annona squamosa*
Tamarind	*Tamarindus indica*
Tangelos	*Citrus paradisi x C. reticulata*
Tropical Almond	*Terminalia catappa*


FECHA DE DEVOLUCION